W. B. No. 567

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CHARLES F. MARVIN, Chief

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CONTENTS.

NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the MONTHLY WEATHER REVIEW (e. g., January) should be in the hands of the Editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for the illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

REPRINTS are made up without covers in the original size and pagination of the REVIEW. They will not be furnished unless specifically requested when the manuscript is submitted.

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INTRODUCTION.

As explained in this Introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS to the MONTHLY WEATHER REVIEW will be published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Beginning August, 1915, the material for the MONTHLY WEATHER REVIEW will be prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office. Occasional original papers by prominent students of seismological phenomena.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; Tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meteorological Summary and chart No. 9 of the North Atlantic Ocean for this month, in 1914. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general appropriate officials prepare the seven sections above enumerated; but all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.

The voluminous tables of data and text relative to local climatological conditions that during recent years were prepared by the 12 respective "district editors" are omitted from the MONTHLY WEATHER REVIEW, but collected and published by States at selected section centers.

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence, the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are especially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belen College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASURED AT WASHINGTON, D. C., DURING OCTOBER, 1915.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., November 16, 1915.]

In Table 1 are summarized the measurements of the intensity of direct solar radiation made by the Weather Bureau at the American University,[1] Washington, D. C., during October, 1915. The means for the month are slightly lower than the 5-year means published in the Bulletin of the Mount Weather Observatory, 1912, **5**:182, Table 3.

Skylight polarization, measured at solar distance 90° and in his vertical, with the sun at zenith distance 60°, averaged 64 per cent, with a maximum of 70 per cent on the 23d. This latter is 6 per cent higher than the average maximum polarization for October published in the Bulletin of the Mount Weather Observatory, 1910, **3**: 114, Table 16, and 1 per cent higher than any polarization measurement previously obtained at Washington in October.

TABLE 1.—*Solar radiation intensities at Washington, D. C., during October, 1915.*

[Gram-calories per minute per square centimeter of normal surface.]

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
A. M.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
October 3	......	......	......	......	......	0.79	0.72	......	......	......	......
4	......	1.02	0.88	0.75	......	......	......	......	......	......	......
8	......	1.07	0.92	0.81	......	......	......	......	......	......	......
9	......	1.30	1.20	1.12	1.05	0.97	0.88	0.82	0.77	0.72	0.66
10	......	1.32	1.22	1.14	1.06	0.98	0.93	0.87	0.83	0.76	0.72
11	......	1.31	1.09	1.00	0.97	0.94	0.87	0.81	0.76	0.70	0.65
12	......	1.33	1.25	1.18	1.11	1.04	0.98	0.91	0.86	0.82	0.79
23	......	1.38	1.08	0.93	0.74	......	......	......	......	......	......
25	......	1.15	......	0.94	0.86	0.75	......	......	......	......	......
26	......	1.14	1.01	0.89	0.79	0.73	0.68	0.63	......	......	......
28	......	1.09	0.97	0.90	......	0.76	......	......	......	......	......
30	......	......	......	......	0.84	0.76	......	......	......	......	......
31	......	......	......	......	1.05	1.01	0.98	0.94	0.89	0.84	0.79
Means	......	**1.21**	**1.07**	**0.97**	**0.94**	**0.87**	**0.86**	**0.83**	**0.82**	**0.77**	**0.72**
P. M.											
October 4	......	1.22	1.07	0.93	0.84	0.75	......	0.57	......	......	......
8	......	1.12	1.23	1.16	1.04	0.91	0.81	0.72	......	......	......
11	......	1.31	1.17	1.08	1.01	......	0.87	0.80	......	......	......
12	......	1.31	1.22	1.13	1.06	0.99	0.92	0.86	0.80	......	......
21	......	1.25	1.14	1.04	0.93	0.84	0.76	0.69	0.63	......	......
23	......	......	1.26	1.16	1.06	0.98	0.91	0.84	0.79	0.73	0.70
25	......	......	1.00	0.89	......	0.67	0.61	0.57	0.52	0.48	......
27	......	1.23	1.15	1.05	0.96	0.88	0.82	0.77	0.72	0.69	0.64
28	......	......	0.93	0.80	0.72	0.65	0.61	0.57	0.53	0.49	0.45
30	......	......	1.14	0.91	0.85	0.83	0.81	0.79	0.76	0.73	......
Means	......	**1.24**	**1.13**	**1.02**	**0.94**	**0.83**	**0.79**	**0.72**	**0.68**	**0.62**	**0.60**

In Table 2, column 2 gives the daily totals of solar and sky radiation received on a horizontal surface at the American University during October, 1915. The measurements were made with a Callendar recording pyrheliometer, as described in the REVIEW for March, 1915, **43**: 100. Table 2, column 3, gives the daily departures from the normals published in the same number of the REVIEW, page 110, Table 4.

The "Percentage of possible sunshine" and the "Average cloudiness," given in columns 5 and 6, Table 2, have been taken from the records of the observatory of the central office of the Weather Bureau. The monthly mean percentage of possible sunshine is 63, or practically the same as the normal for October.

[1] For a description of exposures of instruments and details of methods of observation see this REVIEW, December, 1914, 42:648.

The above data indicate the usual number of hours of sunshine during October, but radiation intensities slightly below the average for the month. The third decade was the only one showing radiation in excess of the normal.

TABLE 2.—*Daily totals and departures of solar and sky radiation at Washington, D. C., during October, 1915.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.	Departure from normal.	Excess or deficiency since first of month.	Percentage of possible sunshine.	Average cloudiness.
	Gr.-cal.	*Gr.-cal.*	*Gr.-cal.*	*Per cent.*	*0-10.*
October 1	61	−275	− 275	1	10
2	196	−138	− 413	17	8
3	381	50	− 363	100	0
4	411	83	− 280	100	1
5	136	−190	− 470	9	9
6	199	−124	− 594	28	8
7	64	−256	− 850	0	10
8	390	72	− 778	93	3
9	357	42	− 736	75	3
10	438	126	− 610	100	0
11	433	123	− 487	100	0
12	429	122	− 365	100	0
13	322	18	− 347	54	6
14	189	−113	− 460	22	9
15	294	− 5	− 465	74	6
16	34	−262	− 727	0	10
17	57	−236	− 963	0	10
18	92	−198	−1,161	0	10
19	244	− 43	−1,204	44	8
20	137	−147	−1,351	4	10
Decade departure	....	....	− **741**	....	....
October 21	289	8	−1,343	75	3
22	339	61	−1,282	97	2
23	366	91	−1,191	100	0
24	390	118	−1,073	100	0
25	335	66	−1,007	100	0
26	300	34	− 973	92	3
27	330	67	− 906	88	3
28	297	37	− 869	100	0
29	303	46	− 823	83	5
30	338	83	− 740	100	0
31	309	57	− 683	100	1
Decade departure	....	....	**668**	....	....
Total excess or deficiency since first of year	....	....	**−1,704**	....	....

EFFECTS OF HURRICANES ON THE UPPER AIR CURRENTS.

By Prof. W. H. PICKERING.

[Dated: Mandeville, Jamaica, Nov. 13, 1915.]

It is well known to astronomers that if we point a telescope on a bright star, remove the eyepiece, and place the eye near the focus, we shall perceive a bright disk crossed by dark fluctuating dots or lines due to air currents in our upper atmosphere. The same result is obtained if we draw out the eyepiece a few millimeters beyond the focus. In the latter case if we determine the number of millimeters, we can readily compute the altitude of the current whose motion we are observing. The dark lines travel longitudinally, and the diameter of the objective divided by their number gives us the linear distance between them.

It has been the writer's fortune, good or bad, to be on the island of Jamaica during the passage of four hurricanes in its vicinity. The atmospheric definition, which is of fundamental importance in all astronomical observations, is exceptionally good on this island, as it probably is in most tropical countries as compared with what is found in northern latitudes. In each case, however, a few days before the passage of the hurricane the definition, or "seeing" as it is usually called, dropped to a very marked degree, indeed it became as bad as it usually is in the north. Such bad "seeing" is never experienced here unless a hurricane is in the vicinity. To express the fact numerically, the "seeing" usually fluctuates here

from 8 to 12, the latter being perfect. On rare occasions it drops to 6, which is about the best we have in Cambridge, Mass. At the approach of a hurricane the "seeing" drops to 4 and sometimes to 3.

This fact was first noted in August, 1899, at the time of the passage of a severe hurricane to the north of Haiti. The center was at a distance of 450 miles and did not reach Jamaica (Annals, Harvard Observatory, v. **61**, p. 21). The next observation was from our present station in Mandeville in 1912. On the evening of November 9 the "seeing" had been rather poor, 7, but at midnight it suddenly dropped to 3. After that we had continuously cloudy nights and no observations were secured for two weeks. The disturbance was not announced by the Weather Bureau until November 12, but on the 9th the center was probably located about 500 miles to the south of us. On November 15, 16, and 17 we had 19.70 inches of rain, but the center did not pass us until the 18th. It came within 25 miles of us, and the maximum velocity of the wind was estimated at 55 miles.

The third hurricane observed occurred in August of the present year. On the evening of the 10th the seeing in the zenith was noted as 11. The next afternoon the highest maximum temperature in three years was recorded here, 88.7°F. and we were informed that the Weather Bureau indicated a disturbance south of Porto Rico, some 800 miles to the east of us. Since the hurricane center is always small, the chance that it will strike us is not very great. We do not consider its mere proximity as a very dangerous phenomenon, either to ourselves personally or to our instruments, but it is certainly a nuisance. It not only always damages our bananas and shrubs, but it interferes for a number of days with our observations. It was therefore with some considerable interest that we turned our telescope to the zenith that evening to look at the indications. There was no mistaking them, the seeing had dropped to 4, and the image was constantly fluctuating in both size and shape. Yet to the naked eye the stars appeared as steady as usual, no twinkling being visible at a greater altitude than 30°. The center passed 50 miles to the north of us at 3 a. m. of August 13. The maximum wind velocity was estimated at 40 miles, but it may have been rather higher in the nighttime. The total rainfall on the 12th, 13th, and 14th was 15.85 inches.

Our fourth hurricane came in September. On the night of the 21st the seeing on the moon was recorded as 8. Doubtless in the zenith it would have been higher, perhaps 10. The next night at 8 o'clock it was reduced to 5, and at 4 o'clock the following morning to 4. There was no doubt but that there was trouble again to the east of us. The distance of the center at this time was 750 miles. We focused on the air currents, and found them coming from the east 20° south, rather slowly, the lines occasionally breaking into dots. They came pretty nearly direct from the storm center. The distance between the lines was 1.5 to 2 inches. It was a very dry night, with the stars twinkling up to an altitude of 50°. The next afternoon, September 23, we received a Government report of a disturbance to the eastward. In the evening the seeing was the same, 4, but the bands now moved more swiftly and were farther apart, about 3 inches. Their direction was the same. The current therefore now came from slightly to the north of the center. The stars twinkled up to an altitude of 45°. There was a good deal of cloud after 9 p. m. September 24 was a rainy evening, but we got a few glimpses of the stars between the hurrying clouds. The direction of the bands had now shifted to east 6° south, which was parallel to the motion of the center, and their velocity was so high that we could not tell whether they were traveling east or west. Their breadth had increased to 5 inches. The wind came in gusts from the east, estimated at 8 miles. The center was now some 200 miles to the southeast of us.

Our telescope is of 11 inches aperture, furnished with a diagonal eyepiece for zenith observations. When the eyepiece was pulled out 5 millimeters beyond the focus, the air currents were easily seen, and even at 2 millimeters they were visible. This latter would correspond to an altitude of 6 miles. The lowest altitude observed was 1.5 miles. The direction seemed to be the same at both altitudes, but observations could only be made through occasional holes in the clouds, while it was not desirable to expose the telescope to the frequent showers. Observations were therefore somewhat imperfect.

The writer has received a tracing of the path of this hurricane through the kindness of the Government meteorologist, Mr. Maxwell Hall.[1] The center passed 90 miles to the south of us early September 25. The wind was not estimated higher here than 25 miles. The total rainfall on September 25, 26, and 27 was 18.39 inches, 9.90 inches falling on the first date, which is our record for the past three years.

22° HALO WITH UPPER AND LOWER TANGENT ARCS.

By C. G. ANDRUS, Assistant Observer.

[Dated: Weather Bureau, Richmond, Va., Oct. 26, 1915.]

The cirro-stratus clouds which covered the sky at noon October 26, 1915, at Richmond, Va., were the occasion for a complete solar halo in combination with the upper and lower tangent arcs (*c* and *d?*, fig. 1) that are sometimes observed with this halo. The radius of the halo (as measured with the device described in this REVIEW, May, 1915, p. 214) was 21° 30′. The lower summit resembled a parhelion and was of a bright, whitish color, but of little lateral extent. The upper summit was longer, of better colors, and had a flattening effect on the appearance of the halo at this point.

At 12:50 p. m. (75th mer. time) there was little change in arrangement, but the colors were more brilliant.

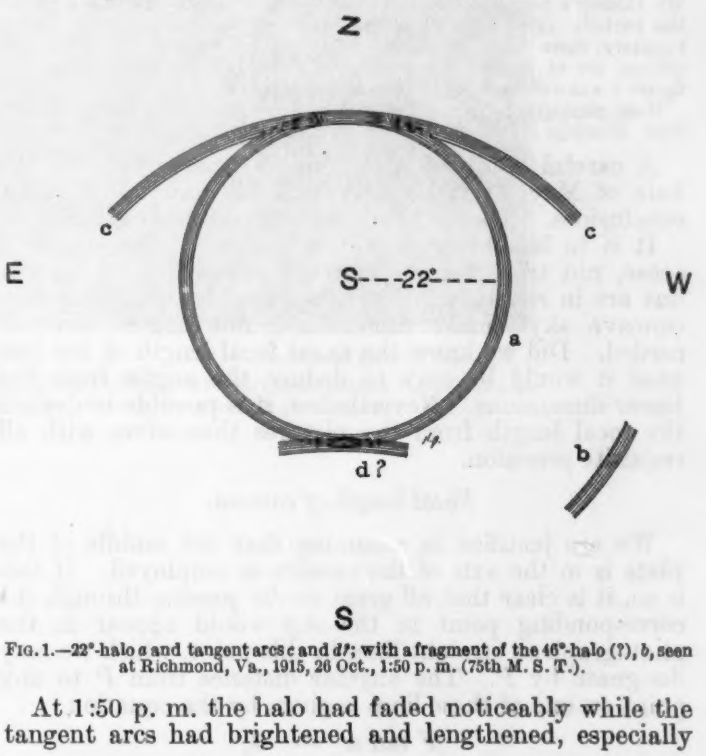

FIG. 1.—22°-halo *a* and tangent arcs *c* and *d?*; with a fragment of the 46°-halo (?), *b*, seen at Richmond, Va., 1915, 26 Oct., 1:50 p. m. (75th M. S. T.).

At 1:50 p. m. the halo had faded noticeably while the tangent arcs had brightened and lengthened, especially

[1] Details of the experience of Jamaica during these hurricanes of August and September, 1915, will be found in the Jamaica Weather Report, Nos. 445, 446, and 447.—C. A., jr.

the upper one. The distance from *c* to the upper summit (see drawing) was about 75°; from *c* to the sun, 30° approximately. For a few moments at this time a faint, colored arc (*b* in fig. 1) was visible in the southwest sky at about 45° distance from the sun and apparently concentric to the halo; it displayed the colors of the spectrum in good definition with the red appearing on the side nearer the sun.

The halo and tangent arcs continued visible until 3:10 p. m., when a covering of alto-cumulus clouds had obscured the whole phenomenon.

EXPERIMENT ON SUNSET COLORS.[1]

By F. W. JORDAN.

[*Reprinted from* Science Abstracts, Sec. A, Oct. 25, 1915, §1403.]

The purity of color in a diffraction halo[2] depends essentially on the size of the condensed droplets. The author describes a simple experiment in which the motion and distribution of the different-sized water droplets in a cloud are partially controlled. The colors obtained on illuminating the cloud with sunlight are comparable with those of soap films and present the features of sunset colors. It is concluded that some of the brilliancy and extensiveness of sunset colors is due to a quiescent state or regular motion of the clouds or mist at sunset and also to a distribution into layers of droplets of nearly uniform size.—*T. Harris.*

HALO OF MAY 20, 1915, ANALYZED.

By Prof. CHARLES SHELDON HASTINGS.

[Dated: Sloane Laboratory, Yale University, Oct. 25, 1915.]

[Early in September of this year Mr. A. M. Comey, of the Eastern Laboratory, Du Pont Powder Co., Chester, Pa., sent this Bureau two very interesting photographs of the solar halo of May 20, 1915, as seen at Chester, Pa. (lat. 39° 50′ N.; long. 75° 20′ W.). The first view, shown in figure 1, was taken at 11:15 a. m. (75th mer.) with a Zeiss wide-angle lens of Series 5, using stop 64 and 1/100 second exposure. The second photograph was taken at 11:45 a. m., and showed the features reproduced in figure 3. In this REVIEW for May, 1915, we presented a large photograph of the corresponding halo seen at New Haven, Conn.; Mr. Comey's photographs are of additional interest, since they record the parhelic circle as well as the circumscribed halo of 22°. Unfortunately these photographs were unable to record the brilliantly colored arc of the 46°-halo, reported from both localities, although figure 3 was extensive enough to have included it.

Both photographs from Chester have been studied and analyzed by Prof. Hastings and the results are communicated below.—C. A., jr.]

A careful study of Mr. Comey's photographs of the halo of May 20 yields a remarkable amount of exact conclusions. These I shall endeavor to make clear.

It is to be observed that the photographs are, in a sense, not true pictures of what one might have seen, but are in reality a projection on a plane of lines in a concave sky—linear dimensions, not angles, are recorded. Did we know the exact focal length of the lens used it would be easy to deduce the angles from the linear dimensions. Nevertheless, it is possible to deduce the focal length from the pictures themselves with all requisite precision.

Focal length of camera.

We are justified in assuming that the middle of the plate is in the axis of the camera as employed. If this is so, it is clear that all great circles passing through the corresponding point in the sky would appear in the photograph as straight lines in this point, which we may designate by *P*. The angular distance from *P* to any point on one of these lines is given by the equation

$$F \tan \alpha = d,$$

where *d* is the measured distance by any scale and *F* is the focal length in the same units. Moreover, according to any theory of halos the angular distance separating the highest point of the halo from the lowest point is very nearly 44 degrees; or for a photographic view, in which violet light is most effective, we may estimate this distance as equal to 44.6 degrees. These considerations and direct measurement of the photograph give us the following set of equations for the photograph of figure 1:

$$F \tan \alpha = 1.48 \text{ in.}, \; F \tan \beta = -4.15 \text{ in.}, \; \alpha - \beta = 44.6°.$$

The corresponding equations for the photograph of figure 3 are as follows:

$$F \tan \alpha = 4.30 \text{ in.}, \; F \tan \beta = -0.64 \text{ in.}, \; \alpha - \beta = 44.6°.$$

The only uncertainty here depends on our assumption as to the adjustment of the camera and my own estimate as to the position of the beginning of the brightest portion of the ring. The solution of the first equations gives $F = 5.54$ in. and of the second $F = 5.51$ in., values in sufficiently close agreement.

Circumscribed halo and parhelic circles.

The position of the zenith in figure 2 is pretty accurately fixed, since the parhelic circle is well defined and that portion near the sun is so close to *P* that it is little distorted. My estimate from this plate makes the zenith distance of the sun equal to 26.1°. The zenith distance of the sun at the time the second photograph was taken is not so easily found, chiefly because of the faintness of the image of the parhelic circle. My conclusion from measures freed from distortion is a zenith distance in this case of 21.5°, which can not be far from the truth.

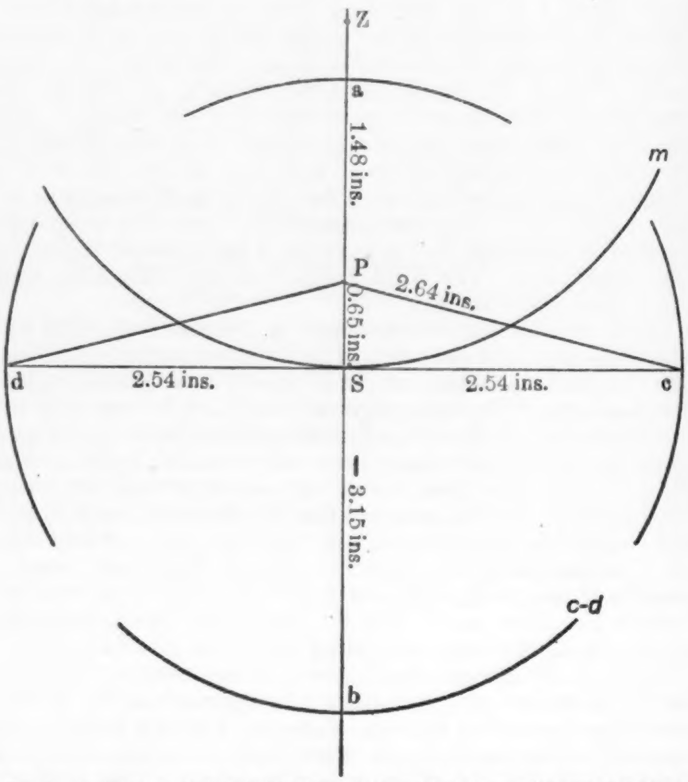

FIG. 2.—Analysis, by Prof. C. S. Hastings, of the original large print reproduced on a smaller scale in fig. 1. The dimensions refer to those of the original print.

The horizontal semidiameter, *Sc*, of the circumscribed halo is found as follows:

Angular distance *P* to *c* (or *d*) is 25.5°, since $F \tan 25.5° = 2.64$ inches.

Angular distance *P* to *S* is 6.7°, since $F \tan 6.7° = 0.65$ inch.

[1] Nature (London), July 29, 1915, 95:590-591. [2] Better termed "corona."—C. A., jr.

(Contributed by A. M. Comey.)

FIG. 1.—Solar circumscribed halo of 22° of 1915, May 20, photographed at Du Pont Powder Co.'s plant, Chester, Pa., at 11:15 a. m. Note almost complete parhelic circle. Sun's zenith distance, 21.5°.

(Contributed by A. M. Comey.)

FIG. 3.—Solar circumscribed halo of 22° of 1915, May 20, photographed at Du Pont Powder Co.'s plant, Chester, Pa., at 11:45 a. m.

Note arc of parhelic circle, which was longer and more distinct in the negative; also failure to photographically record the colored inferior arc of the 46°-halo reported by the observer. Sun's zenith distance, 21.5°.

The measured angle included between these two lines is 75.1°. The third side of the spherical triangle is therefore equal to 24.6°, which is the quantity sought.

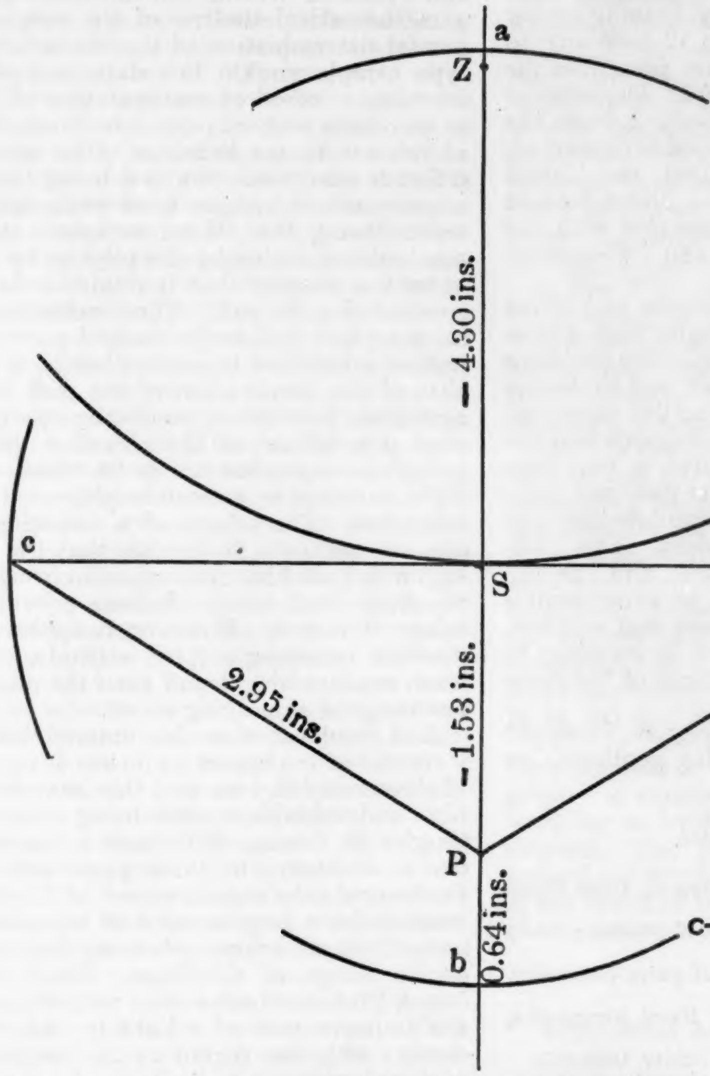

FIG. 4.—Analysis, by Prof. C. S. Hastings, of the original large print reproduced on a slightly smaller scale in fig. 3. The dimensions refer to those of the original print.

The corresponding elements of the triangle in figures 3 and 4 are

P to *c* (or *d*), 28.16°; included angle 59.04°,
P to *S*, 15.52°,

whence third side equals 23.9°.

According to the theory of Venturi, the values of the third side should be 24.5° and 23.8°, respectively. A more convincing proof that the brilliant ring here photographed was in fact the circumscribed halo of 22° (sometimes called Oval of Venturi) could not be demanded. In this connection it may be added that measurements which I have made on Mr. York's photograph[1] taken in this city, yield 23.8° for the angular distance of the east and west points of the oval from the sun at the time it was taken. This also is the theoretical value. I inclose sketches (figs. 2 and 4) of my interpretation of the two photographs, the points chosen in the halo being at the inner edge of the brightest portions.

In the second of Mr. Comey's photographs (fig. 3) the region of the arc of the 46°-halo is depicted with no trace of this feature. This fact is not at all surprising since the arc, although conspicuous on account of the purity of its coloring, was a very faint object in comparison with the splendid circumscribed halo. The same photograph also shows the parhelic circle with a higher sun than has hitherto been recorded, although exceedingly faint. The change in the luminosity of this circle during the half hour which separated the two photographs (figs. 1 and 3) is very significant. According to the generally accepted theory, which explains it by ordinary reflection from the larger surfaces of oriented crystals, it ought to have grown continuously brighter; the explanation which I have offered[2] attributes it to internal total reflection from the smallest surfaces of oriented crystals and this rapid diminution in intensity as the sun rises above 68° [to zenith distances less than 22°] is a necessary consequence.

The scientific interest in the above results lies in two facts: (1) They record a smaller parhelic circle than any heretofore observed; (2) they show that a photograph properly interpreted gives more accurate measures in this field than we can get in any other way.

[1] See this REVIEW, May, 1915, 43:215, plate opposite.

[2] *Hastings, Charles S.* Light. New York, etc., 1902. Pp. 139-153.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

Under the naval appropriation act (Public No. 271, Sixty-third Congress) approved March 3, 1915, the Congress provided for a National Advisory Committee for Aeronautics consisting of not more than 12 members, to be appointed by the President. The act prescribes the membership as follows: 2 from the War Department (office in charge of military aeronautics), 2 from the Navy Department (office in charge of naval aeronautics), 1 each from the Smithsonian Institution, the United States Weather Bureau, and the United States Bureau of Standards, 5 additional persons acquainted with the needs or skilled in aeronautical science and its engineering side.

The duty of the committee is to supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and their application to practical questions. The committee may direct and conduct research and experiment in aeronautics in such laboratories as may happen to be placed under its direction, under rules and regulations for the conduct of the work formulated by the committee and approved by the President. This committee serves without extra compensation and has the sum of $5,000 for five years to devote to experimental work and investigations, clerical expenses and supplies, and necessary expenses of the committee in traveling to and from and while attending the meetings of the committee.

Under the authority granted by Congress President Woodrow Wilson appointed the following gentlemen as members of the committee.

Membership of the Committee.

Brig. Gen. GEORGE P. SCRIVEN, U. S. A., *Chairman*, Chief Signal Officer, War Department.

Naval Constructor HOLDEN C. RICHARDSON, U. S. N., *Secretary*, Navy Department.

Prof. JOSEPH SWEETMAN AMES, Ph. D., Johns Hopkins University, Baltimore, Md.

Capt. MARK L. BRISTOL, U. S. N., Director of Naval Aeronautics, Navy Department.

Prof. WILLIAM F. DURAND, Ph. D., Stanford University, California.

Prof. JOHN F. HAYFORD, C. E., Northwestern University, Evanston, Ill.

Prof. CHARLES F. MARVIN, M. E., U. S. Weather Bureau, Washington, D. C.

Hon. BYRON R. NEWTON, Treasury Department, Washington, D. C.

Prof. MICHAEL IDVORSKY PUPIN, Ph. D., Columbia University, New York, N. Y.

Lieut. Col. SAMUEL REBER, Signal Office, War Department, Washington, D. C.

SAMUEL W. STRATTON, Sc. D., U. S. Bureau of Standards, Washington, D. C.

CHARLES D. WALCOTT, Sc. D., Smithsonian Institution, Washington, D. C.

This committee duly met, drew up rules and regulations for the conduct of the work of the national committee, and organized an executive committee. The President of the United States approved the rules and regulations on June 14, 1915.

WORK DURING 1915.

The following memorandum, covering in a general way the work accomplished by the committee during the past year, was issued by the secretary on October 30, 1915, at the suggestion of the executive committee:

1. The executive committee, acting on authority delegated to it by the advisory committee, entered into contract with the Massachusetts Institute of Technology for a report on the subject of aeroplane stability, which report was submitted by Naval Constructor Hunsaker and Professor Wilson, the substance of the report being a mathematical treatise of the subject and an experimental determination of the characteristics of a normal type aeroplane. On this data and on the basis of an ingenious method of manipulation of Routh's Discriminata, causes and valuable conclusions have been arrived at relative to the behavior of an aeroplane under two different conditions, the first being that of an aeroplane whose controls remain fixed while entering a puff; the second being that of an aeroplane whose controls are manipulated, either by the pilot or by automatic means, in such a manner that it retains a fixed attitude while encountering the puff. The conclusions show that where an aeroplane follows its natural path in encountering a puff, it is elevated to a mean height of about three times that of the acceleration of the puff in feet per second, and then follows an oscillating path, returning to a neutral condition at the elevation given; whereas, the aeroplane controlled so as to maintain its attitude of flight, is raised to a mean height equal to that of the acceleration. The effects of a following gust are of the opposite nature. It appears that the accelerations acting on the machine are such as to bring into play stresses which are well inside of those provided in a factor of safety of 7 or 8. However, it appears that though the machine retaining a fixed attitude, rises and falls less when encountering a puff than the other machine, it has less range of safe flying speed.

2. A contract was also entered into with Columbia University for a report on means of improving the design of aeronautic engines, and this has resulted in a voluminous and valuable treatise being submitted by Professor Charles E. Lucke, of Columbia University. The treatise is divided into three parts and contains, besides Professor Lucke's main report of his investigations and conclusions, a large amount of valuable information collected from all sources, showing the status of aeronautic engine design at this time. Based on the conditions found, Professor Lucke offers valuable suggestions toward the improvement of reliability, adaptability, and efficiency, with due regard to the weight of the complete power plant.

3. Another contract was entered into with the United States Rubber Co., at a nominal sum, for an investigation and report relative to the merits of different qualities of aeronautic fabrics, which includes a report on friction based on tests conducted in the wind tunnel at the Washington Navy Yard. The report shows, so far as friction is concerned, that the friction of all fabrics is reduced to a very satisfactory degree by the use of any good grade of spar varnish, and that surfaces in their natural finish have much greater coefficients of friction. The relative merits of different fabrics as to tensile strength, weight, hygroscopic qualities, fire-resisting qualities, permeability, etc., are discussed in a satisfactory manner. It appears that it is very probable that practically any grade of aeronautic fabric can be made fireproof to a satisfactory degree, though the means used in the experiments were not entirely satisfactory, on account of the deterioration which took place when the necessary compounds were introduced to a sufficient degree to completely destroy the inflammable qualities of the fabric.

4. An effort was made to obtain a report from Cornell University relative to the design of a muffler for aeroplane engines, but by reason of delays in completing the

contract, and unfortunate explosions wrecking the first two devices constructed, this work has been delayed. However, it is probable that further tests may present more satisfactory results.

5. A valuable report was contributed voluntarily by John A. Roebling's Sons Co., on the subject of wire terminals for aeroplane construction. Their report, while not complete, is in very satisfactory form, and shows that it is possible to obtain 100 per cent efficiency of terminal construction with hard wire, strand, and cable. The point is raised that the efficiencies of the different types of wire trussing, based on weight for strength, are in the order of wire, strand, and cable, and it is therefore not clear why there appears to be a general preference in this country and abroad for the use of strand and cable, and it appears that other factors than those considered in the investigation must be of importance, the probable factor being that of elasticity, though no definite reasons for such preference were presented.

6. The Advisory Committee instituted an investigation as to the facilities available in different colleges, technical institutions, engineering institutions, and among manufacturers and various aeronautic societies, for the carrying out of aeronautic investigations. It found that limited facilities were available for attacking various problems of aeronautic design, and that they could be made available to the committee, provided sufficient funds were available to carry out the necessary experiments, or to engage competent engineers on different phases of the work. A large number of colleges have available mechanical laboratories and engineering courses capable of application to aeronautics, but only the Massachusetts Institute of Technology and the University of Michigan so far offer regular courses. Worcester Polytechnic Institute has conducted experiments on full-sized propellers mounted on a whirling table turning on a pivot in the middle of a pond. The arms of the whirling table are provided at one end with a dynamometer for measuring the torque and thrust and revolutions of the propeller, and at the center a control stand for controlling the speed of the propeller. The speed of the rotating arm is controlled by means of a drag in the water, attached to the opposite end of the rotating arm. While there are objections to this method of testing in a circular path in the open, the method is ingenious and the results obtained should be valuable, particularly for comparison. In general, however, it appears that the interest of colleges is more one of curiosity than that of considering the problem as a true engineering one, requiring development of engineering resources, and, therefore, not yet of sufficient importance to engage their attention, except in a fundamental way. Manufacturers, naturally, are principally interested in the development of types which will meet Government requirements, or popular demand, but which will not involve too radical or sudden change from standard types.

7. It was found that the Bureau of Standards is well equipped for carrying on all investigations involving the determination of the physical factors entering into aeronautic design, and is prepared to take up such matters as are of sufficient general interest to warrant same. The bureau had already prepared, but not published, a paper on the subject of Pitot tubes with reference to their use for air speed meters. This paper was prepared by Professor Herschel and Dr. Buckingham. It was submitted to the executive committee in rough form, and the Bureau of Standards is now placing it in form for publication by the committee. It gives an interesting description of the investigation of the properties of different types of air speed indicators.

8. The Navy Department is equipped with a model basin and wind tunnel at the Washington Navy Yard, with adequate shop facilities for carrying on the work in a limited way, and is also constructing at the Washington Navy Yard a plant for the testing of aeronautic motors and devices involved in their operation, which will be in commission at an early date. Also, under the Navy Department steady progress is being made in attacking practical problems involved in the development of the Navy aeronautic service at its station at Pensacola, and theoretical and practical design are in hand in the Bureaus of Construction and Repair and Steam Engineering.

9. The War Department has limited facilities at the flying school at San Diego, for investigations of interest to that branch of the service, and is able to carry out in a limited way experiments of interest to the service on full sized machines, for which work it has the assistance of technical experts.

10. The Weather Bureau is well equipped for the determination of the problems of the atmosphere in relation to aeronautics, and Professor Marvin, a member of the Advisory Committee, is the chairman of a subcommittee engaged on this problem. The work, however, is limited until the necessary funds for more extensive work become available. There is already available in the records of the bureau much information of value which requires compilation in a form suited to aeronautic requirements, and this work will be the subject of a preliminary report to be included in the annual report of the committee.

11. The Smithsonian Institution has been engaged for a number of years on the compilation of the bibliography of aeronautics, and is prepared to continue this work for at least two years more with the funds at its disposal. The Institution has also contributed funds toward the development of the work of the subcommittee of the Weather Bureau in its investigation of the problem of the atmosphere in relation to aeronautics.

SPECTRUM AND TEMPERATURE OF THE SOLAR PHOTOSPHERE.[1]

By A. AMERIO.

[*Reprinted from* Science Abstracts, Sec. A, Oct. 25, 1915, § 1389.]

This lengthy and exhaustive monograph gives a detailed account of the author's researches in this domain. The object of the investigation is set forth and the spectrobolometric arrangement employed is illustrated. It is impossible in a short abstract to cover the whole ground, but a few of the more important results may be referred to. The observations were made in 1908–1911 at 4 stations, namely Rome, Alagna, Col d'Olen, and Capanna Regina Margherita, the atmospheric absorption being calculated by imagining the atmosphere to be divided into 4 strata and assigning separate coefficients to each station, according to its elevation. From the total observations it is deduced that the radiation reaching the earth at the upper limit of the atmosphere, from the center of the solar disk is 2.51 gm. cals. per sq. cm. per min. From this and from the data as to the energy distribution on the solar disk the solar constant 2.09 can be deduced. But the solar atmosphere has the effect of reducing the energy radiated by the photosphere in the ratio 150:100; so that the value of the solar constant if

[1] Mem., Accad. Lincei, 1914, 9, No. 9, p. 323–383.

there were no solar atmosphere would be $2.51 \times 1.50 = 3.76$, which is the photospheric solar constant A_1. The absorption of the solar atmosphere ranges from 33 per cent at angle 0° to 68.7 per cent at 90°; the mean being 44.4 per cent. Applying Stefan's law, this gives a temperature of 6830°C. for the solar photosphere. The author's values for the solar atmospheric absorption for rays of different wave-length, agree well with those of Abbot and Fowle; but the values of q not so well. As regards the spectrum of the photosphere, this is found to be very similar to the spectrum of a black body having the same temperature. The apparent distribution of the total energy over the sun's disk varies with the altitude above sea-level. Finally, since a black body at 6900° will yield 5 per cent of its energy in the form of light, by assuming 20 candles to be obtainable per watt at 7000° we arrive at the figure 150,000 candles per sq. cm. for the luminous intensity of the photosphere; that of the sun's disk is considerably lower, the mean intensity being about 67,000 candles per sq. cm. of surface.—*L. H. W[alter]*.

EFFECT OF ULTRA-VIOLET LIGHT ON THE EYE.[1]

By W. E. BURGE.

[*Reprinted from* Science Abstracts, Sec. A, Aug. 30, 1915, § 1029.]

Cataract is known to be prevalent in the tropics among glass-blowers and among elderly people. The most plausible explanation of the opacity of the eye-lens is that it is due to coagulation of the lens protein, just as egg-white and other proteins may lose their transparency when acted on by certain chemicals or exposed to heat. To test the possible effect of radiation in this respect, excised pig and ox lenses were exposed to an electric furnace, being almost submerged in open vessels containing egg-white, blood serum, aqueous and vitreous humor respectively. When the exposed lenses and media were placed in a tank of running water (with the mouth of vessel slightly above its surface), even an exposure of 100 hours failed to produce any opacity. In other cases in which the media were placed very close to the furnace opacity occurred, but the temperature of the lens had risen to 80°C., and the conclusion was drawn that this [temperature], and not the red or the infra-red radiation, had caused the coagulation. Exposures to the visible spectrum gave rise to similar results. The filament of a 2000-c. p. gas-filled lamp was focused on the lenses, but exposures for as much as 100 hours gave rise to no opacity. On the other hand, opacity could be produced in a few minutes by focusing the image of the sun on the lenses; but in this case also the rise in temperature was sufficient to account for the coagulation. Similar experiments regarding the effect of ultra-violet light were made. A Cooper Hewitt (2500-c. p.) quartz-tube mercury lamp was used. At a distance of 5 cm. below the tube coagulation of egg-white and blood-serum occurred after 20 minutes' exposure, but the lenses were unaffected even after 100 hours, the aqueous humor was still clear and the vitreous humor only slightly clouded. This is interesting, since practically all other protein substances can be coagulated by ultra-violet light.

Now the author, by the analysis of cataractous eyes obtained from India, has found a great increase over the normal in the percentage present of certain chemicals. For example, eyes from India contained appreciable amounts of silicates of potassium and calcium; and in other cases various salts of these metals and of magnesium have been found. The presence of these materials therefore seems to render the protein liable to coagulation. This was confirmed by the author, who repeated the exposure to ultra-violet light on lenses immersed in solutions of magnesium chloride, sodium silicate, and dextrose. Turbidity and even total opacity could be produced in these circumstances. The conclusion would seem to be that certain conditions of health, which give rise to abnormal quantities of such materials (those suffering from diabetes, for example, accumulate increased amounts of dextrose), also predispose the eyes to cataract.

There are thus two distinct factors: (1) the presence of these substances which modify the lens-protein, and (2) continual exposure to rays of short-wave length by which the modified protein may be precipitated. The effective region in the spectrum of the quartz lamp appears to be from $265\mu\mu$ to $302\mu\mu$, the former being the point of greatest activity.—*J. S. D[ow]*.

[1] Elect. World, April 10, 1915, p. 912-914.

ROTATION OF SOLAR CORONA.[2]

By J. BOSLER.

[*Reprinted from* Science Abstracts, Sec. A, Aug. 30, 1915, § 989.]

During the eclipse of the sun on 1914 August 21, photographs of the spectrum of the corona were obtained with a 3-prism spectrograph giving a dispersion of 1 mm. = 32 Å. The eclipse was notable in that the chief corona line in the green region at $\lambda 5303$ was extremely faint, and in consequence determinations of the rotation have been confined to measurements of the new line discovered in the red at $\lambda 6374.5$ Wave-length determinations were made from comparison spectra of the ordinary sunlight 10 minutes after totality. Taking into account that the slit was inclined 18° to the solar equator, the resultant velocity of rotation of the corona gives an equatorial velocity of 3.9 km. per second. This result is in good agreement with that obtained by Campbell in 1898.—*C. P. B[utler]*.

ROTATION OF SOLAR CORONA.[3]

By H. DESLANDRES.

[*Reprinted from* Science Abstracts, Sec. A, Aug. 30, 1915, § 989.]

The importance of finding any definite value for the rotation of the solar corona is discussed from the point of view of its bearing on the theory of the constitution of the corona. Widely different values of the strength of the solar magnetic field have been obtained in different regions—a feeble value of 10^{-7}gauss by Deslandres, for the region of the high prominences, and a strong value of 50gauss by Hale for the lower layers of the solar atmosphere. If the coronal radiation is of the nature of electrified particles being projected outward, it would be reasonable to expect some influence on their velocity owing to their passage through the electric field, and this would modify to that extent the measures of the rotation velocity by line-of-sight measurements at the limb. It is suggested that in the future it would be better to arrange for an artificial comparison spectrum instead of using sunlight.—*C. P. B[utler]*.

[2] Comptes Rendus, April 6, 1915, **160**: 434-437.
[3] Comptes Rendus, April 6, 1915, **160**: 437-440.

SECTION II.—GENERAL METEOROLOGY.

DEFLECTION OF BODIES MOVING FREELY UNDER GRAVITY ON A ROTATING SPHERE.

By CHARLES FREDERICK MARVIN.

[Dated: Weather Bureau, Washington, D. C., Nov. 18, 1915.]

No fundamental principle among the laws of the motions of the atmosphere and ocean currents is perhaps so far reaching in important effects and so difficult for the general student and non-mathematical reader to fully grasp and comprehend, as the deflective influence of the earth's rotation on direction and motion of freely moving bodies. Many expositions of this interesting dynamic problem have been published, and simple explanations are to be found in standard works on meteorology and mechanics. Nevertheless, to many the whole matter is shrouded in obscurity, and those who lack the facility of literally thinking in mathematical equations do not grasp the complete physical reality of the effects or clearly discern the source or character of the actual forces in operation.

In view of the foregoing another explanation and derivation of the deflective forces is now offered that has been developed along the lines of a method already briefly presented in the MONTHLY WEATHER REVIEW.[1] That article, however, presupposes a good deal of knowledge of the subject on the part of the reader and, moreover, fails to indicate clearly the real nature and origin of the deflecting forces and how they act, all of which the present explanation aims to supply. While lacking all the elegance, generality, and directness of the established mathematical demonstrations, the new presentation seeks to visualize and make obvious the several forces, conditions, and effects in a manner that the general student with just the ordinary familiarity with the principles of mechanics and the parallelogram of forces will readily follow and clearly comprehend.

In order that the reader may be better prepared to follow what is presented later it seems proper to say at this point that air in motion, flowing rivers, moving trains, any objects whatsoever moving over the surface of the earth are subjected to a greater or less deflective influence that tends to cause the body to swerve to the right in the Northern Hemisphere and to the left on its onward course in the Southern Hemisphere. In ordinary language these results are said to be caused by the earth's rotation. In fact, however, the deflections are caused by components of gravity which act in this manner whenever any body is set in motion relative to the rotating earth; the moving earth is merely a condition—an essential to the situation. Moreover, the effects are not imaginary or illusive, but are real and due to the action of real forces. Gravity, acting by means of components, is the real source of the deflective influences. When a body not on the Equator moves exactly eastward or westward the deflecting force is a real, lateral component of gravity. In this case the speed of the moving body is not affected in the slightest degree. The *direction of motion* only is changed. For motion exactly northward or southward, however, just the reverse is true. A component of gravity then acts on air moving *toward the pole* to *increase* its eastward velocity and vice versa for air moving equatorward. The deflection toward the east or west, of air moving on the meridian is therefore more apparent than real, in that the deflection results from a change in the actual as well as in the relative velocity of the body in question, and at the start is not literally a change of direction of motion. The effect, nevertheless, is due to a real component of the force of gravity, as will hereafter be shown. As soon as the deflected current acquires any appreciable component of motion eastward or westward the true lateral component of gravity then also acts literally to change the direction of motion. The following will give an idea of the magnitude of these effects: If a ball could be set in motion in a frictionless manner in any direction whatever on a smooth horizontal surface at latitude 40° and at a velocity of 1 mile an hour, the ball would travel in very nearly a closed circle of radius of a little less than 3 miles. Each successive curve thus described would fall a trifle west of its predecessor; and the motion in the circle would be right-handed in the Northern Hemisphere, and left-handed in the Southern Hemisphere. If the ball had a velocity of 10 miles per hour the radius would be ten times as great, and so on. The radius will also have different values for different latitudes.

Before matters now under discussion can be properly understood it seems necessary also to comment briefly upon the confusion in the use of the expression "centrifugal force." This term runs all through studies and discussions of the paths of moving bodies and rotating objects, and prominent writers are sometimes careless in the use of the word, with the result that the beginner and nontechnical reader are hopelessly confused. "Centrifugal force" is not a real force; that is, if the word "force" thus used has the same meaning it has when ordinarily applied to other of the recognized forces.

Whenever any body whatsoever moves along a curved path, some deflective force is always acting perpendicular to the path and directly towards the center of curvature. If it were not for such a radial or centripetal force the body would move in a straight line. A body moving in a curved path always acts *as if* it *tended* to fly away from the center and writers often speak of this tendency as "centrifugal force." It must be distinctly recognized, however, that the "force" or tendency acting *away* from the center is simply an inertia reaction of the body and that there is, in fact, a radial or centripetal force acting on the body to constantly deflect it *toward* the center and away from the straight line it is momentarily following.

Attention having been called to certain sources of confusion and the character of the phenomena under consideration clearly indicated, the real problem before us may now be taken up.

[1] *T. Okada*, in MONTHLY WEATHER REVIEW, May, 1908, **36**: 147.

Let *NESW* in figure 1 be a meridional section of the geoidal figure of the earth with excentricity greatly exaggerated. Let ω be the angular velocity of rotation about the axis *NS*. Imagine a body somehow held at rest at *P*, that is, held so as not to partake of the earth's rotation. The geocentric attraction of the earth for such a body will draw it directly towards the center of mass *C*, and this force may be represented in magnitude and direction by the line *PO* through *C*. If, however, the body at *P* is rotating *with* the earth it will move in a circular path corresponding to the parallel of latitude of its place and must, therefore, be acted upon by a radial centripetal force as *PF*. This force is supplied by the gravitational attraction of the earth, and is, therefore, a component of *PO*, readily shown as such by completing the parallelogram of forces *FOO'P*. The apparent force of gravity at *P* on the rotating earth is, therefore, less than the true geocentric attraction (*PO*) and is shown in amount and direction by the line *PO'*. The force *PO'* lies in the direction of the plumb line at *P* and is necessarily perpendicular to the geoidal surface at the same point, be-

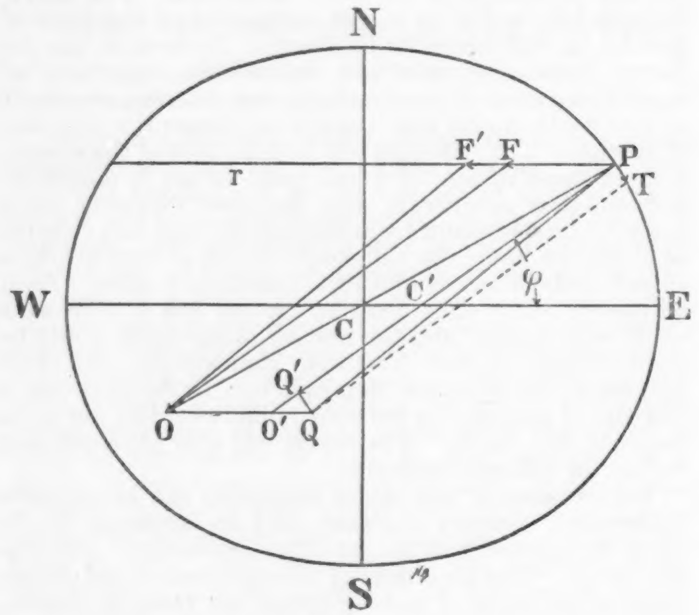

FIG. 1.

cause by definition the geodial surface is one, each point of which is perpendicular to the plumb line at the corresponding point. The angle $PC'E = \varphi$, is the geographical latitude of the place *P*.

Suppose, now, the body or mass, *m*, at *P* moves eastward over the earth at a uniform velocity, *v*, a greater radial force than *PF* now becomes necessary to compel the body to remain on the surface of the earth. Let *PF'* represent the new force which, as before, is a component of the central gravitational attraction of the earth. The new gravitational forces acting on the body (now moving eastward) are found by completing the parallelogram *F'OQP*. The component *PQ* is now the apparent force of gravity for a body at *P moving eastward* at velocity *v*. This force, however, is no longer perpendicular to the geoidal surface; hence a component of force to cause horizontal motion arises, so that by resolution of forces we get the attraction *PQ'* strictly perpendicular, and the tangential component *PT*, which is the sought-for deflective force. As the body is supposed to be moving eastward (perpendicular to the plane of the picture in this case) it is plain *PT* acts to deflect the motion to the right. If the body moves from east to west, the radial force *PF'* must be less than *PF*, and it is easy to see this would cause the point corresponding to *T* to fall on the other side of *P*, and the body would be deflected polewards but still to the right of its onward course.

It is interesting to notice that, while *PO'* represents the attraction of gravity on a stationary mass of air at *P*, the attraction for and hence the barometric pressure of this same air mass moving eastward at velocity *v* is less, and is represented by *PQ'*.

The formula for stating the value of *PT* may be found as follows:

Let $PC'E = \varphi$ = the geographic latitude of *P*.
ω = angular velocity of earth's rotation
= velocity of particle at unit distance from axis.
v = linear velocity, west to east, of body at *P*.
r = distance from surface to axis of earth at latitude φ.
f_o = deflective force for east-west motion,
= $QQ' = PT$.

The actual angular velocity of a body moving eastward at *P* with velocity v is

$$\omega + \frac{v}{r}$$

(If the body moves westward $\frac{v}{r}$ will be negative.)

Therefore the radial force, *PF'*, necessary to maintain motion in a circle is

$$PF' = m\left(\omega + \frac{v}{r}\right)^2 r = OQ,$$

also

$$PF = m\omega^2 r = OO',$$

$$FF' = PF' - PF = O'Q,$$

Therefore for the deflective force QQ' we have

$$f_o = QQ' = O'Q \sin\varphi = m\left[\left(\omega + \frac{v}{r}\right)^2 r - \omega^2 r\right]\sin\varphi,$$

that is,

$$f_o = m\,r\left(\frac{2\omega v}{r} + \frac{v^2}{r^2}\right)\sin\varphi.$$

Except very near the poles, or for very high values of v, such as might occur, for example, in studies of the motions of projectiles, the term $\frac{v^2}{r^2}$ will be so small that it may be neglected, in which case the deflective force becomes

$$f_o = 2\,m\omega v \sin\phi$$

Since, as was pointed out above, the attraction of gravity on a moving mody is not only less than when the body is at rest on the earth, but is also inclined to the plumb line at the same place, it may be pointed out as a direct corollary that the mean surface of a moving river is not strictly horizontal. The angular deviation from a horizontal surface is represented in the diagram by tne angle *QPQ'*.

DEFLECTION FOR MOTION NORTH AND SOUTH.

To understand how gravity accomplishes this result it is necessary to be familiar with a fundamental principle of the dynamics of bodies moving freely under attractive forces like gravity. This principle is the law of equal areas or the constancy of angular momentum. It is fully explained in elementary textbooks of astronomy, and when applied to the case of air moving over the rotating surface of the earth this law requires that the square of the distance from the axis of rotation multiplied by the angular velocity must be a constant, so that if r is the distance from the axis and ω the angular velocity, then $r^2\omega$ = constant.

This product is also called the angular momentum. The upper portion of figure 2 represents a meridional elevation of the Northern Hemisphere. Below is shown one-half of a circumpolar projection of the same region. Let us suppose that a body at rest on the earth at A will be carried to A' in a short time, t seconds, by reason of

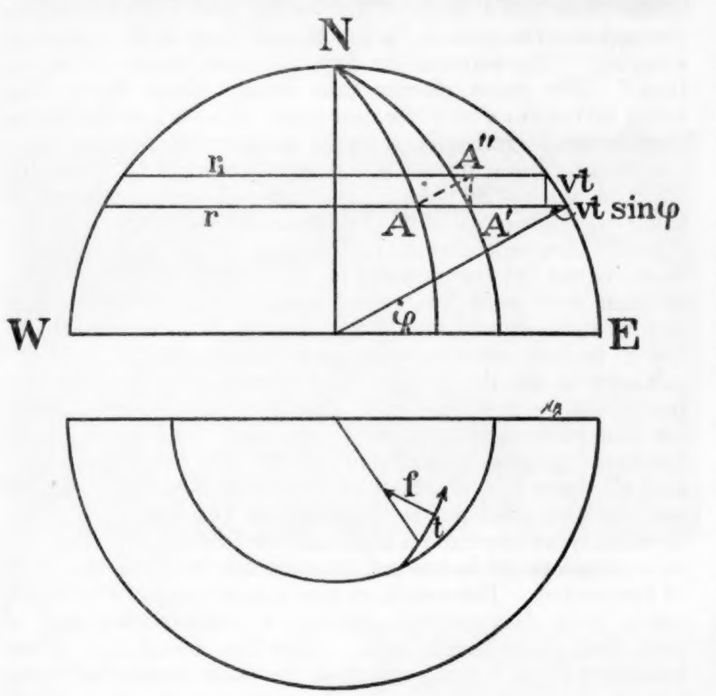

FIG. 2.

the earth's rotation. Let ω indicate the angular velocity of this motion. If now the body at A is moving northward at the uniform velocity V it will not be found at A' at the end of time, t, but will occupy a position as at A''. In this position it is nearer the axis of the earth than before, that is, r_1 is smaller than r and the angular velocity of the body must be greater, because the law of equal areas requires that

$$r^2\omega = r_1^2\omega_1, \qquad \text{or} \qquad \omega_1 = \frac{\omega r^2}{r_1^2}.$$

The gain in angular velocity in t seconds is, therefore,

$$\omega_1 - \omega = \frac{\omega r^2}{r_1^2} - \omega.$$

Strictly speaking the rate of gain in velocity is not necessarily the same from instant to instant when the changes of latitude of the moving body are considerable, nevertheless for all meteorological purposes we may safely neglect secondary variations; that is, assume that the rate of change in angular velocity is constant. Therefore, the gain in velocity in one second is $\frac{\omega_1-\omega}{t}$. Now the gain in velocity of a body in one second is commonly called "acceleration" and may be represented in the present case by a. Moreover since the surface velocity in the position A'' equals r_1 times the angular velocity we may write

$$\frac{(\omega_1-\omega)r_1}{t} = a = \omega\left(\frac{r^2-r_1^2}{tr_1^2}\right)r_1,$$

$$a = \omega\,\frac{(r+r_1)\;(r-r_1)}{tr_1}.$$

Now for the motions taking place in a small interval of time like one second, and except for places quite near the pole, r and r_1 are very nearly equal, so that $\frac{r+r_1}{r_1}=2$.

Referring to the portion of the upper figure at the right-hand side, it is plain that when t is a relatively small time the difference between the two radii r_1 and r is given by the equation $r-r_1=vt\sin\varphi$. From these values we get

$$a = 2\omega v \sin\varphi.$$

A body moving steadily northward is, therefore, found to gain eastward velocity at the rate shown by the above equation. To an observer unconscious of the earth's rotation the body seems to move from A' to A'' as if it were deflected eastward by some deflecting force. Since it is customary to measure forces by the product of mass by acceleration we can write in this case

$$f_n = ma = 2m\omega v \sin\varphi.$$

From this we find the deflective effect in the case of north-south motion is of exactly the same numerical value as in the case of east-west motion.

It will doubtless be admitted from the foregoing, without further demonstration, that any body moving in any direction over the surface of a rotating sphere seems to be deflected by a force of the magnitude given in the following equation

$$f = 2m\omega v \sin\varphi.$$

As the proof of this brings out a point of some interest this also will be briefly given.

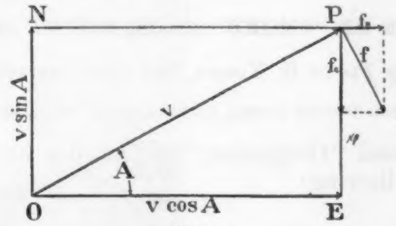

FIG. 3.

In figure 3 let OP represent the velocity and direction of motion of some body. This motion can be regarded as compounded of an eastward motion OE and a northward motion ON. Let v equal the velocity of motion along OP; then

Northward velocity = ON = v sin A,
Eastward velocity = OE = v cos A.

From the previous demonstration we have

$$f_n = 2m\omega v \sin A \sin \varphi.$$
$$f_e = 2m\omega v \cos A \sin \varphi.$$

These deflective forces are shown in the diagram, also their resultant deflection f, the value of which must be

$$f = \frac{f_n}{\sin A} = 2m\omega v \sin \varphi. \quad (1)$$

or

$$f = \frac{f_e}{\cos A} = 2m\omega v \sin \varphi.$$

Viewed in this manner the deflective influence on any moving body may be regarded as compounded of an effect for motion in the meridian, which we have found accelerates or retards the angular velocity of the moving body, and another effect for motion on a parallel of latitude which changes the direction of motion without affecting velocity.

A little examination will show that the deflective action must be to the right in the Northern and to the left in the Southern Hemisphere.

How gravity acts to accelerate the eastward motion of the body is clearly shown in the lower part of figure 2. As the body moves northward it moves spirally inward towards the axis of the earth. The action of gravity in this direction is inclined to the path and one component of this force, t, accelerates the motion, while the other, f, neutralizes the "centrifugal" tendency, that is, keeps the body from flying off on a tangent.

To compute numerical values of forces by equation (1) the proper units must be employed. There is practically only one unit of force in scientific use, namely, the dyne. In order that the equation may give the force in dynes, it is necessary simply that v be measured in centimeters per second and that the angular velocity of the earth, ω, be expressed in angular amount of motion per second. The earth makes a complete rotation in one siderial day, that is, in 86,164 ordinary seconds. Since the whole circumference is 2π,

$$\omega = \frac{2\pi}{86{,}164}.$$

Since high wind velocities expressed in centimeters per second are inconveniently large numbers, some may prefer to express v in miles per hour. The equation then becomes:

$$f_{\text{dynes}} = 0.006520m\, v_m \sin \varphi.$$

CAUSE OF "SMOKE" FROM MOUNT HOOD.

By FLOYD D. YOUNG, Assistant Observer.

[Dated: Weather Bureau, Portland, Oreg., Nov. 9, 1915.]

The Portland "Oregonian" of October 21, 1915, published the following:

MOUNT HOOD SEEN TO SMOKE—PECULIAR PHENOMENON OBSERVED BY RESIDENTS OF THE DALLES.

(Special.)

THE DALLES, OREG., *October 20.*

Groups of citizens here this afternoon, about 5 o'clock, watched for many minutes a circle of smoke which appeared to be issuing from the vicinity of the crater of Mount Hood, 1,000 feet below the summit.

It was smoke from the crater or a most peculiar atmospheric condition never before seen at that point on the mountain. Before nightfall all the town was interested, as the stories of the various groups of witnesses became noised about. Many old residents were among the watchers.

This is the latest of a long series of such reports sent in at intervals from various towns in the vicinity of Mount Hood; hardly a year of the last decade has passed without the so-called smoke being seen from some locality. This report, like its predecessors, was telegraphed by the news syndicates to all parts of the United States and like its predecessors, it evoked a great deal of discussion and denial from geologists. Probably this latest story gained more credence than the ones of former years, on account of the late activity of Mount Lassen in California.

Geologists unite in saying that the mountain has not been active since the earth became inhabited and that the danger of an eruption at this time is inconsiderable. Instead of being a potential source of evil, a dormant volcano ready at any time to burst forth and overwhelm the surrounding country, Mount Hood is really one of the great natural resources of the State of Oregon. It acts as a great reservoir, storing up water in the form of snow all through the winter and gradually giving it up through the dry summer months, so that the water stages of the four rivers that have their origin at its base vary but little throughout the year. In the Hood River Valley there is a saying, "The warmer the day, the more water for irrigation." The great glacier that brings Hood River into being advances down the mountain side during the winter months and gradually retreats before the summer sun. On some summer days the temperature at the foot of this ice field reaches 85°F. and over, and the rapid melting of the ice is made evident by the continual clatter of the bowlders as they roll down the long steep terminal moraine. Were it not for the melting snows of Mount Hood many streams now used for water power would be practically dry in summer and the city of Portland, Oreg., would be forced to look elsewhere for its water supply.

There is no doubt that the observers who saw the mountain "smoking" were sincere in their statements, for the phenomenon is not unusual. There are three kinds of "smoke" that rise from the top of Mount Hood and all three are dependent on meteorological conditions and on the peculiar topography of the mountain top. Evidently at one time a high inward-facing cliff extended in a complete circle around the summit, forming the walls of the crater. The southern and eastern segments of this circle have disappeared, leaving a semicircular wall of rock facing west and north. (See figs. 1 and 2.) When loose dry snow is present below the cliffs inside the crater rim, a strong wind blowing from the south or east will sweep it to the middle of the arc and there throw it high into the air.

A case of this kind was witnessed by the writer from Portland on October 25, 1915. The sun was rather low in the west and was locally obscured by clouds, but it shone full on the mountain and brought it out in bold relief against the sky. A thin plume of white was rising from the top of the peak to a considerable height, and then curling off toward the north. It was so plain as to be unmistakable, wavering in the wind, now rising, now falling, until it finally disappeared entirely. From the time it was first seen until it disappeared was about four minutes, but it is not known how long the "smoke" had been rising before it was seen. That the wind was blowing from the south was shown by the movement of a few small clouds east of the mountain top and at about the altitude of the summit.

The second type of "smoke" is explained by the great variety of cloud forms that are seen around the mountain at different times. Small clouds have often been seen to drift into the open side of the crater ring and be transformed into an almost perpendicular column of vapor by

FIG. 1.—Mount Hood, Oreg., viewed from timber line on the south slope.

FIG. 2.—Mount Hood, viewed from above timber line on the south slope, showing circular cliffs remnant of the crater wall. The rock in the center of the snow field is Crater Rock.

FIG 3.—Summit of Mount Hood, looking down upon the clouds.

FIG. 4.—Strato-cumulus viewed from the southern slope of Mount Hood.

FIG. 5.—View of the top of Mount Hood showing the black rocks within the crater rim.

the rising air currents where the cliffs converge. Cloud banners have been known to hang over the mountain for hours and sometimes whole days at a time, though these clouds do not often have the appearance and form of a smoke column. A comparison between the altitudes of some common cloud forms and that of the summit of the mountain may be made by referring to figures 3 and 4, taken from the summit and from a spot about half-way up the southern slope, respectively.

A third possible explanation of the phenomenon rests on the fact that there are large patches of rock within the crater rim that are hot enough to vaporize any water that may fall on them. In figure 5, the black surface in the foreground is warm enough to keep the snow melted at all times. A hot surface of this kind lies almost directly under the cliffs forming the crater rim, and it is thought that if a snowslide should occur that would throw a large quantity of snow on that spot, the steam generated could be seen some distance. To the writer's knowledge, this has never been actually seen to occur, but the hypothesis seems plausible; and it is likely if ever such a thing really takes place, the snow slides down during the winter months when it is practically impossible to ascend the mountain.

THE MAKING OF FORECASTS BY LAYMEN.

[U. S. Weather Bureau, Washington, October, 1915.]

[The central office recently addressed the following remarks to the Weather Bureau personnel. We reprint them here because of their undoubted interest to the general public. The bureau desires to encourage the development of the art of forecasting and to stimulate the study of the subject throughout the country. So far as it is possible to transfer the forecasters' experience to paper, the Weather Bureau does so from time to time as is shown by the nature of various articles the bureau has published and expects to publish in the future. The following remarks are made solely in the interest of the public.—C. A., jr.]

No doubt many of the officials of the Weather Bureau have, from time to time in the past, aided in giving currency to the idea that every man can be his own forecaster. In a certain sense this becomes possible if there is some familiarity with the source of weather forecasting and if a weather map of recent date is available.

In view of the difficulties of accurate forecasting in the long run, however, it seems desirable not to encourage a too literal acceptance of the idea in question. Especially is this the case where the impression exists on the part of horticulturists, business men, and others who may have important interests at stake in connection with forthcoming weather conditions, that their own ability to forecast the coming weather is sufficient for their guidance in the conduct of their business or agricultural affairs.

The reasons for the caution here advanced, and which should be conveyed to those inclined to depend too largely on their own knowledge of the weather map, should be sufficiently obvious to the members of the Weather Bureau. Experience has already fully demonstrated that, while the recognized principles of weather forecasting are common property in so far as concerns the fact that they have been set forth in numerous publications, very few even among those who give their daily attention to the subject have developed exceptional skill in making the forecasts. Furthermore, the weather maps as issued—which must necessarily be the sole basis of an individual forecast—do not contain all of the information that has passed under the scrutiny of the official forecaster before he issues the forecasts and warnings. Not only at the district forecast centers, but to a larger extent at the Washington office, there are prepared supplementary charts covering the changes in pressure and temperature within a given preceding period, etc., which play their part in the final determination of the forecast issued.

It will thus be readily seen that, whatever may be the justification for an individual to attempt to make his own deductions from the weather map with reference to his particular interests, it will be much better for him to place his reliance upon the official forecasts and information issued by the Weather Bureau. These considerations justify the Weather Bureau in discouraging the idea that satisfactory forecasts can be made by anyone merely because he possesses a fair knowledge of meteorological laws.—*C. F. Marvin, Chief of Bureau.*

PROFESSOR CLEVELAND ABBE.

[U. S. Weather Bureau, Washington, D. C., Dec. 3, 1915.]

The news that Professor Cleveland Abbe has been under the necessity of taking an extended leave of absence on account of ill health will be received with regret not only by his coworkers in the Weather Bureau, but throughout the scientific world.

Professor Abbe [who is now just 77] has had 44 years of distinguished service in the Weather Service and Weather Bureau of the Government. Through his excellent work and eminence in the application of meteorology he has come to be regarded as the "dean of the Weather Service." During this period he has been indefatigable in the pursuit of his favorite branch of science, while his enthusiasm served to enlist the interest of a number of young students who later made their mark in the development of meteorology as a science.

Professor Abbe's long and able editorship of the Monthly Weather Review and his numerous contributions to meteorological science are well known to the members of the Weather Bureau, as well as to meteorologists the world over, all of whom will wish for him a complete recovery and an early return to the congenial duties in which he has been engaged for so many years.

The above was recently communicated to the personnel of the Weather Bureau, but is also of interest to other readers of the Review.—C. A., jr.

PENNSYLVANIA WEATHER AND CLIMATE IN 1682.

William Penn, founder of the State of Pennsylvania, first trod the soil of the land on the Delaware, granted him by Charles II of Britain, on October 28, 1682. Before this time he had actively agitated the advantages of country life and of emigration to the New World, had drafted a form of government for his colony, and had actually sold as much as 600,000 acres of his grant to prospective settlers. Numerous settlers had preceded Penn, a multitude accompanied and immediately followed him; and by the time he wrote the *Letter* quoted below, settlements dotted the rivers several miles inland. Along the Delaware River settlements reached from Lewes to above the Falls at Trenton, and shortly before writing the *Letter* Penn had made a general tour of his lands so that he had freshly in mind full information from his own observations.

The original draft of the *Letter* is preserved by the Historical Society of Pennsylvania. Published versions

of the *Letter* appeared in English, Dutch, German, and French. The original English edition was published by Andrew Sowle in London in 1683 and a fac-simile of its title page is published in an important historical work by Julius Friederich Sachse.[1] A fac-simile of the English edition was reproduced by James Coleman of London in 1881. One of the early German translations in manuscript is in the Royal Privy Archives in Munich; it has been photographed and published by Prof. Marion Dexter Learned [2] and also published by Emil Heuser.[3]

Penn's letter is of some interest to us today because it presents an excellent description of the weather, seasons, and climate of Pennsylvania in 1682 and 1683. The following extract presents those paragraphs treating of the meteorological conditions of his colony; it is from the text published by A. C. Myers,[4] who followed the fac-simile English edition by Coleman in 1881. Those interested in these early documents bearing on the history of our country are referred to Mr. Myers' volume.

LETTER FROM WILLIAM PENN TO THE COMMITTEE OF THE FREE SOCIETY OF TRADERS, 1683.[4]

My kind Friends;

* * * * *

I. The country it self in its soyl, air, water, seasons and produce both natural and artificial is not to be despised. The land containeth divers sorts of earth, as sand yellow and black, poor and rich: also gravel both loomy and dusty; and in some places a fast fat earth, like to our best vales in England, especially by inland brooks and rivers, God in his wisdom having ordered it so, that the advantages of the country are divided, the back lands being generally three to one richer than those that lie by navigable waters. We have much of another soyl, and that is a black hasel mold, upon a stony or rocky bottom.

II. The air is sweet and clear, the heavens serene, like the south-parts of France, rarely overcast; and as the woods come by numbers of people to be more clear'd, that it self will refine.

III. The waters are generally good, for the rivers and brooks have mostly gravel and stony bottoms, and in number hardly credible. We have also mineral waters, that operate in the same manner with Barnet[5] and North-hall,[6] not two miles from Philadelphia.

IV. For the seasons of the year, having by God's goodness now lived over the coldest and hottest, that the oldest liver in the Province can remember, I can say something to an English understanding.

1st, Of the Fall, for then I came in: I found it from the 24th of October, to the beginning of December, as we have it usually in England in September, or rather like an English mild Spring. From December to the beginning of the moneth called March, we had sharp frosty weather; not foul, thick, black weather, as our north-east winds bring with them in England; but a skie as clear as in Summer, and the air dry, cold, piercing and hungry; yet I remember not, that I wore more clothes than in England. The reason of this cold is given from the great lakes that are fed by the fountains of Canada. The winter before [i. e. of 1681–82] was as mild, scarce any ice at all; while this [winter] for a few days froze up our great River Delaware. From that moneth to the moneth called June, we enjoy'd a sweet Spring, no gusts but gentle showers, and a fine skie. Yet this I observe, that the winds here as there, are more inconstant in Spring and Fall, upon that turn of Nature, than in Summer or Winter. From thence to this present moneth, which endeth the Summer (commonly speaking) we have had extraordinary heats, yet mitigated sometimes by cool breezese. The wind that ruleth the Summer-season, is the south-west; but Spring, Fall and Winter, 'tis rare to want the wholesome north wester seven dayes together: and whatever mists, fogs, or vapours foul the heavens by easterly or southerly winds, in two hours time are blown away; the one is always followed by the other: a remedy that seems to have a peculiar Providence in it to the inhabitants; the multitude cf trees, yet standing, being liable to retain mists and vapours, and yet not on quarter so thick as I expected.

V. The natural produce of the country, of vegetables, is trees, fruits, plants, flowers. The trees of most note are, the black walnut, cedar, cyprus, chestnut, poplar, gumwood, hickery, sassafrax, ash, beech and oak of divers sorts, as red, white and black; Spanish chestnut and swamp, the most durable of all: of all which there is plenty for the use of man.

The fruits that I find in the woods, are the white and black mulberry, chestnut, wallnut, plumbs, strawberries, cranberries, hurtleberries and grapes of divers sorts. The great red grape (now ripe) called by ignorance, the fox-grape (because of the relish it hath with unskilful palates) is in it self an extraordinary grape, and by art doubtless may be cultivated to an excellent wine, if not so sweet, yet little inferior to the Frontimack, as it is not much unlike in taste, ruddiness set aside, which in such things, as well as mankind, differs the case much. There is a white kind of muskedel, and a little black grape, like the cluster-grape of England, not yet so ripe as the other; but they tell me, when ripe, sweeter, and that they only want skilful vinerons to make good use of them: I intend to venture on it with my French man this season, who shews some knowledge in those things. Here are also peaches, and very good, and in great quantities, not an Indian plantation without them; but whether naturally here at first, I know not, however one may have them by bushels for little; they make a pleasant drink and I think not inferior to any peach you have in England, except the true Newington. 'Tis disputable with me, whether it be best to fall fining the fruits of the country, especially the grape, by the care and skill of art, or send for forreign stems and sets, already good and approved. It seems most reasonable to believe, that not only a thing groweth best, where it naturally grows; but will hardly be equalled by another species of the same kind, that doth not naturally grow there. But to solve the doubt, I intend, if God give me life, to try both, and hope the consequence will be as good wine as any European countries of the same latitude do yield.

* * * * *

Your kind cordial friend, WILLIAM PENN.

Philadelphia, the 16th of the 6th Moneth, call'd August, 1683.

Penn goes on to describe and discuss the fauna by land and sea, the Indians and their language, customs, laws, other European settlements, and the interests of the company. Since our interests center chiefly on the meteorological and climatological conditions, with their effects on agriculture, we need not continue Penn's text.

To one who pays systematic attention to the weather and climate of the eastern United States, particularly of the Middle Atlantic States, the quoted passages from Penn's hand convey a clear idea of the weather he had experienced. Although he lacked precise instrumental aids, the latter could not have improved his description and his recognition of the characteristic weather features. We of to-day can see at once that the general and actually important features of Atlantic coast weather and climate were the same in 1682 and 1683 as now. The "extraordinary heats" from June to August are no strangers to us of the present; and the actual construction of the better houses throughout Maryland and Virginia bear testimony to those "cool breezes" from the southwest in summer.

Penn's description of the winter in the Middle Atlantic seaboard fits the present as well as it undoubtedly describes the past. His explanation of the cold as "given by the great lakes that are fed by the fountains of Canada" would not hold to-day. We find a better one in an account by David de Vriess [7] who was exploring the Delaware during February, 1633. On his return to his ship the men—

Did not imagine that we had been frozen up in the river, as no pilot or astrologer could conceive, that in a latitude from the thirty-eighth and a half to the thirty-ninth, such rapid running rivers could freeze. Some maintain that it is because it lies so far west; others adduce other reasons; but I will tell how it can be, from experience and what I have seen, and that is thus: inland, stretching towards the north, there are high mountains, covered with snow, and the north and northwest winds blow over the land from these cold mountains, with a pure, clear

[1] *Sachse, Jul. Fr.* The Fatherland: (1450–1700) showing the part it bore in the discovery, exploration, and development of the western continent, with special reference to the commonwealth of Pennsylvania. Part I. ... Philadelphia, 1897. 8°. p. 191, plate xix.

[2] *Learned, Marion D.* German translation of William Penn's letter to the Free Society of Merchants in London, 1683. Germ. amer. annals, Philadelphia, 1910, (O.S.), 12:52–75, illus.

[3] *Heuser, Emil.* Pennsylvanien im 17. Jahrhundert und die ausgewandertem Pfälzer in England. Mit 3 Faksimile-Drucken. Neustadt a. d. Hardt 1910. [iv] 82p. 12°.

[4] *Extract from* **Myers, Albert Cook.** Narratives of early Pennsylvania, West New Jersey and Delaware, 1630–1707. New York, 1912. 8°. (Original narratives of early American history.) p. 224–244.

[5] i. e. Chipping Barnet. or High Barnet, Hertfordshire, 11 mis. north of London. It has a mineral spring on the town common.—A. C. M.

[6] Northaw, Hertfordshire, about 4 miles northeast of Chipping Barnet, has a fine saline spring formerly much resorted to.—A. C. M.

[7] *A. C. Myers*, op. cit., pp. 25–26.

air, which causes extreme cold and frost, such as is felt in Provence and Italy, which I have often experienced when I was at Genoa, when the wind blew over the land from the high mountains, making it as cold as it was in Holland. I have found by experience in all countries, during winter, that when the wind blows from the land the hardest frost makes. It is so in New Netherland also, for as soon as the wind is southwest, it is so warm that one may stand naked in the woods, and put on a shirt.

Again Penn's idea that clearing away the trees would improve the cloudiness or fogginess, while representative of his times, would not be generally accepted to-day as a safe method to follow. However, his observations show a keen appreciation of nature; and we are fortunate in having his letter preserved. It helps to forge one more link in the chain of evidence tending to prove that no permanent discernable change has been taking place in our climate.

One phenomenon of interest is not recorded in the extracts above. Penn makes no mention of the weather which we call "Indian summer." Two explanations for the omission occur to the writer: (1) A busy administrator might have failed to remark the season, experiencing it but once. Indian summer is often not well marked, and attracts attention rather by its repetition than by striking characteristics; Penn had been here but one year when he wrote his letter. (2) The fall of 1682 may not have presented a recognizable Indian summer at all, so that Penn really had not had an opportunity to observe it in America. However, Penn must have subsequently experienced many such Indian summers, and so acute an observer must have described this season somewhere in his writings. Can we find those descriptions, and does he there employ the term "Indian Summer"?[a]—C. A., jr.

ON WATERFALL ELECTRICITY AND ON THE SURFACE CONDITION OF LIQUIDS.[1]

By P. LENARD.

[*Reprinted from* Science Abstracts, Sec. A, Oct. 25, 1915, § 1446.]

The present communication forms part of a larger work on the problem of complex molecules. Under the name "waterfall electricity" the author includes the electrical phenomena accompanying waterfalls, splashing brooks, and rain, also water jets and drops as produced in the laboratory. In these cases the water becomes positively electrified while the negative charge passes into the air. Experiments have also been undertaken of bubbling air through water and of breaking water into spray, and the same phenomena found, so that these latter are classified under waterfall effects. For explaining these electrical accompaniments the liquid surfaces are assumed to be the seat of an electrified double layer, and the observed effects are due to the separation of this double layer whereby a charge of one sign remains in the liquid while the opposite one passes into the surrounding atmosphere. The varying forms of the effect are due to the different modes of separation. The present paper contains an investigation into the mechanism of the waterfall effect, and into the behavior of liquid surfaces considered as the seat of electrical and material stratification.

Section I deals with the superficial concentration of complex molecules and the forces operating on them. Here the idea of complex molecules receives detailed explanation, their distribution in the surface layer is considered, and the dimensions of the superficial forces comprehensively treated.

Section II deals with the waterfall effect as a consequence of the electrical nature of the molecular forces. First comes a detailed treatment of the electrified double layer at the surface; the surface tension in vacuo is found to be not much different from its value in air, while there is no frictional electricity developed between water and air. The rapid disappearance of liquid surface (e. g., by impact on a wetted surface, by water drops falling into water, or by coalescence of drops) is next considered, and the conclusion drawn that the separation between air and water is not the active agent in the production of the waterfall effect. Ordinary distribution of fluid is ineffective; spraying, on the other hand, brings about the effect, and in general the separation of very small liquid particles from the surface acts as a fundamental cause. The waterfall theory of thunderstorms is next exhaustively discussed. Important evidence that contact electricity between gas and liquid is not the origin of waterfall effects is afforded by the very small influence which the nature of the gas exerts, comparative experiments having been undertaken with hydrogen, methane, nitrogen, carbon monoxide, air, and oxygen.

Section III deals specially with the surface conditions of fluids. Every liquid surface has been found to consist of a number of strata which are both electrically and materially different from each other, and such stratification extends to a depth equal to the sphere of activity. From a knowledge of these strata may be gathered an insight into such surface phenomena as surface tension, waterfall effect, photoelectric activity, etc, also the influence of dissolved substances. Purely dielectric fluids, such as water, alcohol, benzol, are first considered, the surface constitution, the field strength of the double layer, and the waterfall effect being critically examined. Following this comes the behavior, from every standpoint, of dissociated nonvolatile electrolytes, i. e., dilute aqueous salt solutions, and a comparison is made by varying the anions and kathions. The nature of the carriers of the various electrical effects is next discusssed. Partially dissociated nonvolatile electrolyte, e. g., concentrated salt solutions, then receive attention, followed by undissociated nonvolatile fluids—for instance, sugar solution. Solutions of volatile solutions, such as aqueous solutions of hydrochloric acid, ammonia, alcohol, and ether are then treated and finally the surface behavior of metallic mercury is considered.

Some of the general conclusions are as follows: A simple expression has been found for the surface concentration of solutions of nonvolatile substances and analogous fluid mixtures. An insight was afforded into the surface behavior of liquids containing molecules of different dimensions, by an investigation into the dependence between the molecular surface forces and molecular volumes. It has been shown in six different ways that the electrified double layer whose presence at liquid surfaces is shown by the waterfall effect, does not originate through contact electricity between gas and fluid, but that its seat is entirely within the fluid in such a way that the external molecular layer is negatively and the interior layer positively charged. The cause of this double layer lies in the electrical nature of the molecular forces, and in like manner can be regarded the phenomenon of contact electricity on dielectric bodies. The different forms of the waterfall effect, as also its presence under certain conditions and its absence in others, are explained from

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[a] It is well-known that the Swedish pastor John Campanius kept weather records 40 years earlier than this letter, at the Swedish settlement in Delaware. A reference to his observations is given in this REVIEW, December, 1901, **29**: 565: and a summary of his observations is printed in the Climatological Summary for the Maryland-Delaware Section, November and December, 1901. They have been presented by Nicholas Colin in Trans. Amer. Phil. Soc., Philadelphia, 1818, **1**:340-352, in connection with later observations from other sources, and published in detail by Campanius' grandson in "Kort beskrifning om Nya Sveriga," Stockholm, 1702, 4°.

[1] *See* Ann. d. Physik, July 8, 1915, **47** IV: 463-524.

the standpoint of disturbance experienced by the electrified double layer. The waterfall theory of thunderstorms now appears probable since the discrepancies hitherto attached to it have been removed by the preceding results. A large number of singularities accompanying the waterfall effect, together with the photoelectric activity and the surface tension of different fluids, can be traced to their surface conditions.—*H. H. Ho[dgson]*.

GAGE APERTURE AND WEIGHT OF CATCH.

By Prof. Charles N. Haskins.

[Dated: Dartmouth College, Hanover, N. H., Nov. 20, 1915.]

In connection with the problem of determining snowfall or rainfall by weighing, I note the following simple relation which seems to be of interest in that it enables private observers to determine the precipitation in this way without the use of specially graduated balances. The relation is: If the diameter of the gage is 10.5 inches, the rainfall in hundredths of an inch is equal to twice the weight of the catch in ounces. This relation is true to within about 1 part in 2,500, which is of course of ample precision. The proof of this results from a simple calculation.

ATMOSPHERIC-ELECTRIC OBSERVATIONS ON THE THIRD CRUISE OF THE "CARNEGIE," 1914.[1]

By W. F. G. Swann.

[*Reprinted from* Science Abstracts, Sec. A, Oct. 25, 1915, § 1447.]

The general course covered by the cruise was from Brooklyn (left June 8) to Hammerfest in northern Norway; from Hammerfest (July 25) northward to latitude 79° 52′ N. in the neighborhood of Spitsbergen, and then southwestward to Reykjavik in Iceland (Aug. 24), and so back to Brooklyn. The measurements discussed in the present report are those of potential gradient, conductivity, and the radio-active content of the air. Potential gradients were measured by the use of an ionium collector projecting from the stern of the ship connected to a Wulf bifilar electroscope. The standardization of this apparatus was carried out by means of simultaneous ship and shore observations on two occasions. The conductivity was measured by Gerdien's method, and a few observations were also taken of the ionic numbers. The radio-active content was measured by the stretched-wire method of Elster and Geitel with certain modifications devised by the author. There is some uncertainty as to what the measurements obtained by this method really mean, and a considerable amount of discussion is devoted to the point.

The mean potential gradient found on the voyage was 93 volts per meter. The measurements were made between 9 a. m. and noon, at which period of the day Simpson and Wright found in the South Atlantic a mean value of 80 volts per meter; so that, considering the difficulties in the way of obtaining absolute readings, there is a fair agreement between the two results. The mean conductivity was 2.52×10^{-4} electrostatic unit. This is rather greater than the average value found on land. Passing out to sea from the American shore, the conductivity appears first to fall somewhat below the normal land value, and then increases again as the vessel gets out into the open sea. This distribution was observed both on leaving and returning to the shore. The local decrease near the shore is found to be due to a low value of the specific velocity of the ions in the same region. The electrical results have been grouped in various ways with the different meteorological elements, but no marked relationships are found. In discussing the radio-active content, the mean value expressed in Elster-and-Geitel units is found to be 23, corresponding to about 12×10^{-12} curie of radium emanation per cubic meter. This amount is much smaller than would be necessary to account for the conductivity of the air. A similar result has been found by most observers. In the latter portion of the paper an application of the theory of radio-active disintegration is made to the decay curves obtained in the Elster-and-Geitel method, and it is found that while some of the curves can be accounted for by the presence of radium emanation alone in the atmosphere, others appear to require the presence of some more slowly decaying products than those of radium emanation.—*J. S. Di[nes]*.

[1] *See* Terrest. magn., March 1915, 20: 13–48.

FOGGY DAYS IN MANCHESTER, ENGLAND.[1]

By W. C. Jenkins.

[*Reprinted from* Science Abstracts, Sec. A, Oct. 25, 1915, § 1377.]

An inquiry as to whether the number of foggy days in Manchester [England], has increased or decreased in the past 10 years. A distinction is drawn between "fog days" or days of surface fog, and "gloom days" or days on which there was fog at a little distance above the surface but not actually on the ground. The figures for the 10 years are arranged in various ways, and it is found that taking the year as a whole the number of foggy and gloomy days combined has increased 30% between the beginning and ending of the period. The most marked part of this increase is in the number of days of gloom.—*J. S. Di[nes]*.

PHYSICAL CONDITIONS OF THE ACCUMULATION OF THE SUN'S HEAT IN THE SALT SEAS.[2]

By M. Rózsa.

[*Reprinted from* Science Abstracts, Sec. A, Oct. 25, 1915, § 1381.]

The investigation of the accumulation of the sun's heat in some salt seas was first undertaken by Kalecsinzky, and the problem in general solved. In the present paper a report is given of the special physical conditions of the warming process, and some experimental researches in connection with this. It is found that a considerable accumulation of the sun's heat can only occur in those salt seas in which the upper layers increase in concentration in consequence of a more permanent diffusion process.—*A. E. G[arrett]*.

ABSORPTION OF ULTRA-VIOLET AND INFRA-RED RADIATIONS BY ARABLE SOIL.[3]

By J. F. Tristan and G. Michaud.

[*Reprinted from* Science Abstracts, Sec. A, Aug. 30, 1915, § 982.]

Photographs were taken in ultra-violet light through a quartz lens, silvered after Liebig, which is transparent to light of from 3100 to 3300 Å units. For the photo-

[1] *See* Mem. Manchester lit. and phil. soc., Apr. 30, 1915, No. 5, 59: 1–4.
[2] Physik. Zeits., Mar. 15, 1915, 16: 108–111.
[3] *See* Archives des sciences, March, 1915, p. 270–273.

graphs in the infra-red Wood's filters are used, made by Wratten and Wainwright; the preparation of these plates is described. The method for determining the absorption of the light by the soil is not explained at all. Eight pairs of photographs are reproduced showing the darkening of the plates by ultra-violet and by infra-red light, in each case by four soils (calcareous, sandy, clay, humus), in the dry or humid state. The dry soil absorbed much less infra-red light than the humid soil; this effect of moisture, which was most marked in the case of clay soil, was much less noticeable in the case of ultra-violet light.—*H. B[orns]*.

DENSITY OF OXYGEN.[1]

By A. F. O. GERMANN.

[*Reprinted from* Science Abstracts, Sec. A, Aug. 30, 1915, § 1149.]

This paper contains, first of all, a historical survey of the determinations of the density of oxygen, and a description of the special apparatus employed. As a result of his determinations with oxygen, prepared by heating potassium permanganate and purified by liquefaction and fractional distillation, the author obtains the value for the weight of a normal liter of oxygen (at 0°C. and under a pressure of 760 mm. of mercury in latitude 45° at sea-level), of 1.42906 gm. Taking into account the previous determinations of Morley and of Rayleigh, but giving rather more weight to his own determination, the author believes that the most probable value for the weight of a normal liter of oxygen, $L_N = 1.42905$ gm.—*A. Fi[ndlay]*.

ORDINARY AND INTERNAL SEICHES IN LAKE TASAWA.[2]

By K. HONDA.

[*Reprinted from* Science Abstracts, Sec. A, Aug. 30, 1915, §985.]

As in previous investigations, the author constructed a model of this the deepest Japanese lake before making the actual observations, and found experimentally four periods for the fundamental and higher modes of oscillations. Generally speaking, the seiches are most conspicuous in deep lakes, and seldom observable in shallow, but here only faint undulations were detected, using Honda's limnimeters for this purpose. The following causes are given for these inconspicuous seiches in such a deep lake: (1) The form of the lake being nearly circular there is no direction of easy oscillation; (2) surrounded on all sides by steep mountains the lake is generally very calm; (3) the depth being so great, a strong exciting cause is required to make the whole water oscillate.

For the observation of the internal seiches, a Miller pattern deep-sea thermometer, which indicates the maximum and minimum temperatures, was used. An adequate description of the operations is given and the following results obtained: Near the surface the fall of temperature is gradual, but at a depth from 10 to 16 meters is very rapid; afterward it becomes again very slow, tending asymptotically to the temperature of the maximum density of water, 4°C. The usual explanation for the existence of this apparent discontinuous layer is that near the surface the temperature is equalized by the disturbing effect of currents and the waves in the lake. The depth to which the disturbance reaches depends upon its duration, increasing with the period of disturbances. Down to this depth the fall of temperature is very gradual, but the conduction of heat being very small, the fall of temperature in a depth deeper than that where the disturbance nearly vanishes follows a logarithmic law with respect to the depth. Hence the fall is at first very gradual, then very rapid, and afterward becomes more and more slow, so that there is an apparent layer of discontinuity. Similar results are given for the lakes of Inawasiro and Towada. Tables of observations are given, and from the curves (temperature-time for constant depths and depth-time for constant temperatures) two periods are deduced for the approximate values of periods of internal seiches. A short mathematical discussion concludes the paper from which it follows that the two long periods recorded on the limnimeters are due to the internal seiches of the lake. Hitherto in the observations of the ordinary seiches, where the periods are large compared with the natural oscillations of the lakes, these are usually attributed to the effect of wind blowing with some periodicity of slow alternations. From the present investigation, however, the long periods are well explained by the internal seiches of the lakes.—*H. H. Ho[dgson]*.

[1] *See* J. Phys. chem., June 19, 1915, p. 437-477.
[2] *See* Tôhoku Univ., Sci. Reports, 1915, p. 33-42.

ÆOLIAN TONES.[1]

By LORD RAYLEIGH.

[*Reprinted from* Science Abstracts, Sec. A, June 25, 1915, § 718.]

In what has long been known as the æolian harp, a stretched string, such as a pianoforte wire or a violin string, is caused to vibrate in one of its possible modes by the impact of wind; and it was usually supposed that the action was analogous to that of a violin bow, so that the vibrations were executed in the plane containing the direction of the wind. A closer examination showed, however, that this opinion was erroneous and that in fact the vibrations are transverse to the wind. Further, it is not essential to the production of sound that the string should take part in the vibration, and the general phenomenon, exemplified in the whistling of wind among trees has been investigated by Strouhal (1878) under the name of *Reibungstöne* [friction tones]. In Strouhal's experiments a vertical wire or rod attached to a suitable frame was caused to revolve with uniform velocity about a parallel axis. The pitch of the æolian tone generated by the relative motion of the wire and of the air was found to be independent of the length and of the tension of the wire, but to vary with the wire's diameter, D, and with the speed, V, of the motion. Within certain limits the relation between the frequency, N, and these data was expressible by

$$N = 0.185\ V \div D\ .\ .\ .\ (1),$$

the centimeter and the second being units.

Other refinements are here considered and finally the following formula is given:

$$ND/V = 0.195\ (1 - 20.1\nu/VD),$$

where for air at about 20°C. the kinetic viscosity is $\nu = \mu/\rho = 1806 \times 10^{-7}/0.00120 = 0.1505$ c. g. s. For water at 15°C., $\nu = 0.0115$.

The formation of vortices in the fluid flowing past the wires is discussed and some preliminary experiments are described.

Further experiments are still, however, admittedly desirable.—*E. H. B[arton]*.

[1] *See* Phil. mag., April, 1915, p. 433-444.

RESISTANCE OF SMALL PLATES IN A STREAM OF FLUID.[1]

By LORD RAYLEIGH.

[*Reprinted from* Science Abstracts, Sec. A, Aug. 30, 1915, § 976.]

In a recent paper on æolian tones [see preceding abstract] the author had occasion to determine the velocity of wind from its action upon a narrow strip of mirror, the incidence being normal. But there was some doubt as to the coefficient to be employed in deducing the velocity from the density of the air and the force per unit area. Observations both by Eiffel and by Stanton had indicated that the resultant pressure (force per unit area) is less on small plane areas than on larger ones; and although the author used provisionally a diminished value of C in the equation $P = C\rho V^2$ in view of the narrowness of the strip, it was not without hesitation; in fact, experiments had already been commenced which appeared to show that no variation in C was to be detected. Subsequently the matter was carried a little further, and the method is here described.

According to the principle of similitude a departure from the simple law would be most apparent when the kinematic viscosity is large and the stream velocity small. Thus, if the delicacy can be made adequate the use of *air* resistance and such low speeds as can be reached by walking through a still atmosphere should be favorable. The principle of the method consists in balancing the two areas to be compared by mounting them upon a vertical axis, situated in their common plane and capable of turning with the minimum of friction. If the areas are equal, their centers must be at the same distance (on opposite sides) from the axis. When the apparatus is carried forward through the air, equality of mean pressures is witnessed by the plane of the obstacles assuming a position of perpendicularity to the line of motion. If in this position the mean pressure on one side is somewhat deficient, the plane on that side advances against the relative stream until a stable balance is attained in an oblique position, in virtue of the displacement (forward) of the centers of pressure from the centers of figure.

Several arrangements were tested, viz, rectangular strips of equal area, one three times the breadth of the other; circular disks of area 2:1, one disk and two others of total area equal to the first. No deviation from the simple law was detected.—*E. H. B[arton]*.

SELECTED BIBLIOGRAPHY OF FROST IN THE UNITED STATES.

By WILLIAM GARDNER REED and CORA L. FELDKAMP.

[Dated Office of Farm Management, Washington, Nov. 1, 1915.]

INTRODUCTION.

This bibliography has been selected[2] from all the material on frost and frost prevention under American conditions which has come to the attention of the writers. This includes all the material in the classed bibliographies of the John Crerar Library (Chicago), the Library of Congress, the Library of the United States Department of Agriculture, the Weather Bureau Library, and the Library of the Bureau of Plant Industry, as well as references in the MONTHLY WEATHER REVIEW, the Experiment Station Record, and various other agricultural and meteorological publications.

It is believed to cover the subject adequately, but is in no sense a complete bibliography of the published material on frost. It is arranged with the later papers first as most of the work is very recent. Earlier papers have usually not been included when later papers cover substantially the same ground.

The papers marked with asterisks (*) form a group which will give a more or less complete idea of the frost problem and the methods of protecting against frost damage. A series of papers[3] on frost appears in the MONTHLY WEATHER REVIEW, October, 1914; there is also a more popular series in Better Fruit (Hood River, Oreg.), volume 5, number 4, October, 1910.

The State index is an attempt to show the work which has been done in the different States; it includes only papers listed in the bibliography.

FROST DATA (General).

United States Weather Bureau, Climatological Division.
Summaries of climatological data of the United States by sections (tables). Various dates.[4]

Frost data for 106 "sections" of the United States are given. These summaries are continually brought down to date as the issue for each section is exhausted. In the summaries printed before 1914 the summaries give the average and latest date of last killing frost in spring, and the average and earliest date of first killing frost in autumn for numerous stations in each section. In the summaries printed since 1914 the dates for each year of record are given.

1915.

Coit, J. Eliot.
Citrus Fruits (New York: Macmillan) xx+520 p., 151 fig. "Frost and orchard heating." Chap. **14:** 230–276, fig. 72–95.

The more important cold periods are described. Frost forecasting and the factors affecting frost are explained. The phenomena of frosting of citrus fruits are discussed. Methods of preventing frost injury are considered under the following heads: Selection of a relatively frostless locality, using a resistant stock, breeding new resistant stocks, use of mechanical devices to conserve heat, raising the dew point, and slow thawing. Heating with oil heaters is described in detail, with descriptions of various oil pots. The necessity of cooperation is emphasized.

***McAdie, Alexander G.**
Temperature inversions in relation to frosts. Annals, Harvard College Observ. **73:** 168–177, 4 pl.

The physics of frost formation in connection with local air drainage and inversions of temperature is discussed, especially with regard to water vapor relations. The physical bases of the methods of protection are explained.

Malone, R. E.
Smudging an orchard with native material in Alabama. Alabama Tuskegee agr. exp. sta. Bul. **28,** 13 p., tables.

The value of smudging in Alabama is briefly discussed. The experiment-station orchard and the methods of frost protection are described. Smudging material was wet peach prunings and tar. Loblolly pine makes excellent smudging material.

Smith, J. Warren.
Predicting minimum temperatures for frost protection. Ohio naturalist, **15:** 405–408, 1 fig.

Temperature forecasting is explained and a method of obtaining minimum temperatures from the similarity during conditions favorable to frost is suggested.

1914.

Beals, Edward A.
Frost forecasts and frost protection in Oregon, Washington, and Idaho. Mo. weather rev. 1914, **42:** 587.

Frost warnings are issued mainly for the benefit of commercial orchards in which protection is used. Forecasts have saved many crops. Orchard heating is generally practiced.

Briggs, Robert R.
Frost protection in Arizona. Mo. weather rev., 1914, **42:**589–590.

Frost has been little studied in this State, but the possibilities of protection in irrigated areas is becoming of increasing importance.

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[1] *See* Phil. mag., July, 1915, p. 179–181.

[2] Thanks are due to Prof. C. F. Talman, of the Weather Bureau, for valuable suggestions and advice.—Authors.

[3] Reprinted as W. B. No. 542, "Papers on frost and frost protection in the United States." Washington, 1915.

[4] These section summaries were collected as Bulletin W of the Weather Bureau in 1912. *See* "1912 United States Weather Bureau."

* The papers marked with an asterisk (*) form a group which gives a general idea of the frost problem.

***Carpenter, Ford A.**
Utilization of frost warnings in the citrus region near Los Angeles, California. Mo. weather rev., 1914, **42**:569-571, 12 pl. (incl. maps, tables, diagr.).

The character of the region and the influence of location upon frost occurrence and the weather types causing frosts are discussed. Frost forecasts are issued by 11 a. m. Methods of protection and utilization of frost warnings are discussed. Protection, generally by oil pots, is expensive but profitable.

Carpenter, Ford A. & Garthwaite, J. W.
Memorandum on air drainage in the vicinity of the Corona district, California. Mo. weather rev., 1914, **42**:572-573, 5 fig.

The effect of a small arroyo on local temperature conditions is discussed.

Cline, Joseph L.
Frost protection by irrigation in southern Texas. Mo. weather rev., 1914, **42**:591-592, incl. tables.

Protection of early vegetables by covering or flooding is the most successful practice in Texas. Low temperatures frequently occurring with high winds make smudging and heating impracticable.

Culbertson, J. D.
Frost protection in the Limoneira lemon orchards. California State Com. Hort., Mo. Bul. **3**:1-8.

Early fighting was with coal baskets, but oil pots have proved much more effective and less expensive. Fruit is badly sooted, but expense of cleaning is more than covered by the saving due to heating. Adequate equipment is essential. Detailed accounts of cost of equipment are given; the first cost is about $183 per acre, and maintenance, aside from operating expense, is $33.34 annually per acre. This is small compared to other expenses of fruit growing.

Fassig, Oliver L.
The period of safe plant growth in Maryland and Delaware. Mo. weather rev., 1914, **42**:152-158, table, 10 fig. (incl. maps).

Frost records for Maryland have been tabulated for 20 years, 1890-1913. Air temperatures of 32°F. have been considered killing frost. Frost data for Maryland and Delaware are shown by tables and maps.

Frazer, Calvin.
The frost problem up to date. Country gentleman, **79**:360, 392, illus.

A popular discussion of the nature of frost damage and the temperatures dangerous to fruit. The methods of protection and the services of the Weather Bureau in issuing frost warnings are described.

Garcia, Fabian & Rigney, J. W.
Hardiness of fruit buds and flowers to frost. New Mexico agr. exp. sta., Bul. **89**, 52 p., 9 figs.

Degree of cold necessary to kill fruit buds and blossoms varies with the locality; resistance varies also with different stages of development. The bloom is not the most delicate stage. Damage is greater with greater degree and longer duration of cold, and when the low temperature is nearer sunrise.

Garthwaite, J. W.
Letter on frost and frost prevention. Mo. weather rev., 1914, **42**: 571-572.

Many general frost conditions do not seem to hold in the Corona (California) region. Trees are often damaged at the top. The necessity of being prepared for frost at any time is emphasized.

Herrmann, Charles F. von.
Protection against frost in Georgia. Mo. weather rev., 1914, **42**:585-586.

Frost protection in Georgia has kept pace with the rapid growth of horticultural interests, but efficient use is not yet made of the facilities of the Weather Bureau.

***Humphreys, W. J.**
Frost protection. Mo. weather rev., 1914, **42**:562-569, 1 fig.

The physics of frost formation and favorable location for fruit orchards are discussed; the methods of frost protection are stated and criticized, particularly ground covering, air drainage, spraying, screening, heating, irrigation. Frost cure is also discussed.

***Marvin, Charles Frederick.**
Air drainage explained. Mo. weather rev., 1914, **42**:583-585.

It is pointed out that the collection of cold air in low places is not a result of drainage down the slopes, but rather the process of building up from the bottom, in which chilled air moves away from the hillside but does not flow down the slope.

Mitchell, Alexander J.
Frost and frost protection in Florida. Mo. weather rev., 1914, **42**:588-589.

The products in Florida show varying resistance to frost. Winter frosts occasionally damage the more tender plants. Various methods of protection of fruit and truck are in use.

Nichols, Carl.
Frost fighting equipment in citrus orchards. California cultivator, **42**:259, 282, 2 fig.

The equipment for frost fighting in each of the fruit districts of California is described in detail.

Smith, J. Warren.
Frost warnings and orchard heating in Ohio. Mo. weather rev., 1914, **42**:573-583, incl. tables, 5 pl. (incl. maps, diagr.).

Frost protection in Ohio is comparatively recent. "Fruit-frost" stations of the Weather Bureau have been established and frost warnings issued. Protection is largely by heating. Temperatures dangerous to fruit buds are discussed. Studies for frost forecasting are outlined.

Sprague, Malcolm.
Frosts and frost protection in Texas. Mo. weather rev., 1914, **42**:590

Frosts in Texas occur in connection with cold waves. Smudging and heating have been successful in orchards and trucking districts in eastern Texas. Frost warnings have enabled the cutting of sugar cane in time to prevent serious damage.

Thiessen, Alfred H.
Protection from frost in Utah. Mo. weather rev., 1914, **42**:586-587.

Frost damage in Utah occurs in April and May and in the early fall. Forecasting is based on key situations. Protection is largely by heating.

Voorhees, J[ohn] F.
Notes on frost protection in the vicinity of Knoxville, Tenn. Mo. weather rev., 1914, **42**:587.

Protection in Tennessee is still in an experimental stage.

Walker, T. J.
An orange man's dream. California cultivator, **42**:69-70.

A fanciful description of future conditions of mixing the air by electric fans, but with suggestions which may become practicable.

Weldon, George P.
Apple growing in California. California State Com. Hort., Sacramento, **124**, p. 58 fig.
"Injury and protection of apples from freezing." Chap. **12**:70-74, figs. 45-47.

No part of California is free from killing frost. The bud and blossoms are the stages of greatest danger in apples. The character of fruit injury and the methods of protection are discussed. Orchard heating with oil is preferred, fires should be lighted before the temperature drops too low and should be kept burning until well after sunrise. "Orchard heating if done at all should be done rightly."

1913.

Adamson, J. E.
Fighting the big freeze [in California]. Pacific rural press, **85**:321, 328-329, 3 fig. The same reprinted in Mo. weather rev., 1913, **41**:289-291, 1 fig.

The methods used in California in the successful fight against the very serious frost condition of December-January, 1912-1913, are discussed. Protection was mainly by heating. Frequent temperature readings showed the conditions in the groves.

Ballantyne, A. B.
Blooming periods and yields of fruit in relation to minimum temperatures. Utah agr. exp. sta. Bul. **128**, p. 245-261, [10 fig.].

Frosts at blooming time sufficient to destroy the whole crop are usual. Frosts of from 5 to 9 degrees when the buds are moist are less damaging than when the buds are dry. Tables and diagrams of blooming periods, yields, and minimum temperatures are given.

***Beals, Edward A.**
Forecasting frost in the north Pacific Coast States. U. S. Weather Bur. Bul. **41**, 49 p. (incl. tables, 3 fig., 4 diagr., 6 charts).

The occurrence of frost in the fruit region of the north Pacific States is discussed. Forecasts are made by the district forecaster but applied by trained local forecasters. The weather types with which frost occurs are described.

***Chandler, W. H.**
The killing of plant tissue by low temperature. Missouri agr. exp. sta. Research Bul. **8**, p. 143-309, 3 pl., chart.

The literature on the destruction of plant tissue by cold is reviewed and a series of experiments of freezing twigs and buds of various fruit trees described. Freezing to death is a specific set of phenomena in which ice forms in the intercellular spaces and death results because of the withdrawal of water from the protoplasm. With a few exceptions, rate of thawing seems to have nothing to do with death. Maturity increases the hardiness of the tissues. The effect of various other factors on hardiness is described. Killing temperatures for peach blossoms in Missouri vary from 22°F. to 26°F. Killing of buds is not common.

Henry, Alfred J.
Vertical temperature gradients between Mount Weather, Va., and valley stations. U. S. Weather Bur., Mt. Weather Observ. Bul. **6**:35-37, incl. tables.

Comparative data for monthly mean temperatures are given. This is a fundamental study of relation between valley and mountain temperatures.

Herrick, R. S.
Orchard heating and frost prevention. [Portland, Oreg., Pacific horticultural correspondence school], 11 p.

The history of orchard heating and the methods used are discussed. Frost conditions are described. The temperature at which heating is necessary at different stages of development of fruit are stated. The types, care, and use of heaters are discussed.

Kellerman, Karl F.
Suggestions for frost protection. Jour., Washington acad. sci., **3**:53-55.

The value of increased vapor content of the air is discussed and methods of increasing the humidity are suggested.

McAdie, Alexander G.
Frost studies: Determining the probable minimum temperature. Mo. weather rev., 1913, **41**:623-625.

The physics of frost is discussed and the conclusion reached that moisture studies must play an important part in the attempt to forecast the minimum temperature.

McAdie, Alexander G.
Report on recent destructive frosts in California. Mo. weather rev., 1913, **41**:120-122.

Temperatures dangerous to citrus fruits have occurred frequently in California and frost losses have been severe. Protection by organized effort by the use of oil heaters saved much of the crop during the destructive frost of December, 1912. The characteristics of this frost are described with a record of the minimum temperatures.

Merrill, G. E.
The freeze and frost fighting. California cultivator, **40**:227, 230, 231.

The results of the frosts of the winter of 1912-1913 are discussed. Smudging was successful. A central heating plant and heating by steam pipes are advocated. Conditions in Santa Barbara County, California, and in Arizona are described.

[Wood, William.]
Cost and result of frost firing. California cultivator, **40**:260-261.

The exact cost for heating a grove of 14 acres (1,000 trees) of lemons at Duarte, California, is given. The total operation expense for 16 nights was $638.76 and the cost of equipment $573.25.

Woodbridge, T. R.
Smudging costs. Pacific rural press, **85**:588-589.

Detailed schedules of cost of heating at Upland, California, for the season 1912-1913. The total cost per acre per hour was $1.24, including overhead charges and depreciation.

1912.

Alter, J. Cecil.
Does frost fighting pay in Utah? Mo. weather rev., 1912, **40**:606-608.

The cost of heating with oil to keep the temperature at 30° varies from 60 cents per hour per acre when the outside temperature is 29° to $4.20 per hour per acre when the outside temperature is 20°. Below 20° heating has arbitrarily been considered impracticable.

Brandenburg, Frederick H.
Temperatures injurious to peaches, apples, and pears in various states of development. Mo. weather rev. 1912, **40**:426.

The report of a committee of the Fruit Growers' Association of the Grand Valley (Colorado) is given. The following tables are of interest:

Table showing at what temperature smudging is necessary at the various stages of development of peach buds.

Stage.	°F.
Peaches one-fourth inch in diameter	30
Dropping the shuck	31
Setting	31
Full bloom	29 to 30
Buds in pink	22
Buds swelling	15
Buds dormant	−15

Table showing at what temperature smudging is necessary at the various stages of development of apples and pear buds.

Stage.	°F.
Calyx closed	30
Flower gone, calyx closing	30
Petals dropping	31
Fruit forming	30
Full bloom	30
Buds in the pink	25
Buds separating	20
Buds swelling	15

Church, J. E. & Fergusson, S. P.
Avoidance and prevention of frosts in the fruit belts of Nevada. Nevada agr. exp. sta. Bul. **79**, 58 p., 16 pl.

Orchard heating experiments are described. Frost phenomena, weather changes, and frost forecasting are outlined, including descriptions of apparatus. Orchard sites should be on higher ground. Orchards in Nevada can be protected when the temperature falls as low as 22° at a cost of 73 to 95 cents per tree.

***[Coit, J. Eliot.]**
The protection of citrus fruit against frost. Citrus protective league of California (Los Angeles), Cir. **6** [8 p.].

The methods of protection in use in southern California are discussed briefly but adequately.

Cox, Henry J.
The Weather Bureau and the cranberry industry. U. S. Dept. Agr. Yearbook, 1911: 211-222, pl. 6-9.

This is essentially a popular discussion of the material in Bulletin T of the United States Weather Bureau (see 1910, Cox).

Greene, Laurenz.
Orchard heating. Iowa agr. exp. sta. Bul. **129**:129-164, 16 fig.

Late spring frosts cause immense losses in Iowa. Methods of handling oil and use of oil heaters are discussed. Heater tests are described and experience of Iowa growers quoted.

Grubb, E. H.
Orchard heating. Oregon Short Line R. R. Co., Salt Lake City, Utah. 15 p., 5 fig.

An account and brief history of protection in the Grand Valley, Colorado, are given. Crude oil is the best fuel. Heat and smoke are both essential. The cost of equipment for 10 acres with oil for 8 nights is $510. The principles of orchard heating are discussed, and several appliances are described.

Henry, Alfred J.
The temperature at Mount Weather [Va.] and adjacent valley stations. Mt. Weather Observ., Bul., 1911, **4**:310-341, incl. tables, 10 fig.

The temperature relations between the summit and base stations are discussed in detail by seasons. The relation of mountain and valley to low temperatures at night is shown and the vertical temperature gradients with the free air are given.

McAdie, Alexander G.
Covering almond trees for frost protection. Pacific rural press, **83**: 241, 247, 2 fig. *Also* in Mo. weather rev., 1912, **40**: 282-283, 2 fig.

California experiments under a paper cover to prevent radiation are described. It seems probable that enough heat can be conserved by covering to prevent damage.

McAdie, Alexander G.
New heater and vaporizer for frost protection. Pacific rural press, **83**: 388, 4 fig. *Also* in Mo. weather rev., 1912, **40**: 618-619.

A method of using heat and moisture combination is described.

McAdie, Alexander G.
Studies in frost protection. Effect of mixing the air. Mo. weather rev., 1912, **40**: 122-123, 779, 2 fig.

Conditions at Kentfield, California, are described. When surface conditions seemed the same on two mornings frost occurred but not on others, a gale in the upper air prevented low temperatures.

Milham, Willis Isbister.
Meteorology (New York; Macmillan) xvi+549 p., 14 pl., 143 fig., 34 charts. Frost, pp. 213-216, charts 27-28.

Frost and the physical processes resulting in frost are defined. Methods of forecasting frost. Differences between temperatures in shelters and of vegetation. Describes methods of protection. Gives frost data for the United States.

O'Gara, P. J.
A comparative test of fuel oils and appliances used in orchard heating to prevent frost injury. Off. of Pathologist and Local U. S. Weather Bur. Sta. for Rogue River Valley. (Medford, Oregon) Bul **6**, 27 p., 4 fig.

Test of various oil pots and fuel oils under orchard conditions is described in detail. Simple types of oil pots with oil of a medium specific gravity are recommended. The cost of heating is about one cent per hour for each oil pot. The quantity of oil required to raise the temperature of full-bearing orchards 5° above that of the surrounding air is about 12½ gallons an hour, if the wind is not more than 2 miles an hour. Young orchards with low fruiting require about twice as much oil for the same results.

United States Weather Bureau.
Summaries of climatological data by sections. U. S. Weather Bur. Bul. **W**, 2 vols., tables, maps, diagrs.[5]

Climatological data for each of 106 "sections" of the United States are given. These data include the average and latest date of last killing frost in spring and average and earliest date of first killing frost in autumn for numerous stations in each section.

Whitson, A. R., & Baker, O. E.
The climate of Wisconsin and its relation to agriculture. Wisconsin agr. exp. sta., Bul. **223**, 65 p., incl. tables, 24 fig. "Growing season," pp. 24-30, figs. 11-14.

The dates of killing frost in Wisconsin and their relation to agriculture are discussed. Maps of the average date of last killing frost in spring, of the first killing frost in autumn, and of the length of the "growing season" are presented.

***Wilson, Wilford M.**
Frosts in New York. New York Cornell agr. exp. sta., Bul. **316**: 505-544, figs. 135-151.

Conditions favorable to the formation of frost are discussed and successful methods of protection are described with especial reference to New York. Frost data and maps for New York are given.

1911.

Alter, J. Cecil.
Value of mountains to climatic safety for the fruit grower. Mo. weather rev., 1911, **39**: 1248-1249.

The advantage of the broken topography of Utah in preventing the occurrence of late spring frosts except in the very low places is emphasized. The advantage of morning shading by mountains is explained.

Cline I[saac] M.
Freezes of November 13 and 29-30, 1911, in the sugar, orange, and trucking region [of Louisiana and Texas]. Mo. weather rev., 1911, **39**: 1714-1716.

The conditions during the record cold for this time of year are described. The forecasts of cold were made in time and a great part of the crop was saved.

***Day, P. C.**
Frost data of the United States and length of the crop-growing season. U. S. Weather Bur. Bul. **V**, 5 p., 5 maps.

Maps are presented showing average dates of last killing frost in spring, first killing frost in autumn, and length of the growing season, also maps of latest date of last killing frost in spring and earliest date of first killing frost in autumn. Isochronal lines are shown east of the Rocky Mountains and figures given at stations west of the mountains.

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[5] The data for each section are printed separately and continually brought down to date as the issues are exhausted. See "Frost Data" at the beginning of the bibliography.

***Garriott, E. B.**
Notes on frost. Revised August, 1911, by Alexander G. McAdie. U. S. Dept. Agr., Farmers' Bul. **104**, 35 p., 4 fig.

The formation of frost and the seasons of frost in different parts of the United States are briefly discussed. Other atmospheric conditions being favorable, frost may usually be expected when the temperature reported by Weather Bureau stations falls to 40° F. The existence and causes of "thermal belts" are considered. Local soil and moisture conditions influence frost occurrence. Frost data at Weather Bureau stations are presented. Methods of protection from frost by preventing radiation, by adding heat to the air, and by adding moisture are described. Essentials of a frost-fighting campaign are stated. Summaries are given of work in Florida, Missouri, California, Indiana, Oregon, Utah, and Massachusetts.

Gruss, E. W.
Protecting truck against frost. Mo. weather rev., 1911, **39:** 1231–1232.

Truck crops are of sufficient value in Texas to warrant protection. Protection is necessary only occasionally and danger is forecast by the Weather Bureau. Covering and smudging are successful methods of protection.

Gruss, E. W.
Protection against frost. Mo. weather rev., 1911, **39:** 581–582.

The freeze of January, 1911, in southern Texas is discussed. Smudging proved beneficial where used. Precautions necessary to receive and make use of forecasts and also methods of protection are outlined.

Henry, Alfred J.
Variations of temperature at summit and base stations in the central Rocky Mountain region. Mt. Weather Observ. Bul., 1911, **4:** 103–114, incl. tables, 1 fig.

The temperature relations between the base and summit stations in Colorado is discussed. The relations of altitude and location to temperature are described in connection with weather types and movement of air.

Howard, R. F.
Protection of orchards from frost. Better fruit, **6**, no. 5: 36–38, 4 fig.

Conditions of frost occurrence are discussed. Smudging and heating and apparatus are described. A satisfactory method of arranging and lighting heaters is explained.

Lewis, C. I. & Brown, F. R.
Preliminary frost fighting studies in the Rogue River Valley. Oregon agr. exp. sta. Bul. **110**, 62 p., 19 fig.

The work of the station from 1909 to 1911 is discussed. The average cost per acre for a four-hour period was $5.10 for oil, but $5.40 for wood under similar conditions. There is no doubt that crops can be saved by orchard heating. No arbitrary table of temperatures for frost injury has been worked out for all conditions.

McAdie, Alexander G.
Protecting the California orange crop from frost. Mo. weather rev., 1911, **39:** 1910–1912.

Statistics of the citrus fruit industry are given and the relation between this industry and frost fighting are discussed. The topography of the orange region is described. Temperatures on four actual dates from December, 1909, to 1911 are given for various points. Statements of the cost of protection and the amount of saving are quoted.

McAdie, Alexander G.
Work of the Weather Bureau in protecting fruit; especially frost protection. Mo. weather rev., 1911, **39:** 275–276.

Frost warnings, the physical processes of frost, and the methods of protection are discussed.

O'Gara, P. J.
Frost injury prevention methods in Rogue River Valley. Better fruit, **6**, no. 5: 21–30, 17 fig.
Same under title of The prevention of frost injury in the orchards of the Rogue River Valley, Oregon. Off. of Pathologist and local U. S. Weather Bur. Sta. for Rogue River Valley (Medford, Oregon) Bul. **5**, 27 p., 22 fig.

A brief history of frost protection is given. Heating is the common method in Rogue River Valley; wood and oil are burned. Various types of oil pots are discussed. Successful heating saved the fruit crops in 1911. Frost forecasting by the Weather Bureau has made successful fighting possible. Frost fighting campaign must be carefully planned. The methods of protection are described in detail.

Slatuper, D. Lee.
Value of windbreaks and smoke. Gulf coast citrus fruit grower, **1**, no. 6: 18–19.

The freeze of January 2, 1911, is described and the use of wet hay and oil smudges is discussed. The necessity of windbreaks to keep the smoke from blowing away is emphasized.

Thiessen, Alfred H.
Orchard heating. Mo. weather rev., 1911, **39:** 761–762.

Methods of frost fighting in Grand Valley, Colorado, are discussed. The region is effectively organized and the campaign to the last detail planned in advance. Oil and coal heaters are used. Killing temperatures vary with the stage of development of the plant, its previous condition, etc. When the temperature is falling rapidly, fires are lighted at 34° F. Best results are obtained in orchards surrounded by other orchards.

Woodbury, C. G. & Wellington, J. W.
Orchard heating. Indiana agr. exp. sta. Bul. **154**, pp. 71–96, 16 fig.

A number of types of orchard heaters have been devised to prevent frost damage. A series of tests of different types of heaters was made at the station. The temperature was raised from 5 to 7 degrees with 80 to 100 heaters per acre. Oil heaters seem preferable to coal under Indiana conditions. To control temperatures properly requires an initial investment of about $500 for a 10-acre orchard. In most Indiana orchards heating will not pay unless the production is increased by better cultural methods.

1910.

Barney, F. E.
Practicability of orchard heating with coal. Better fruit, **5**, no. 4: 39–40, 2 fig.

The essentials of heaters are discussed and a successful coal heater is described.

Brackett, G. B.
Prevention of frost injury to fruit crops. Better fruit, **5**, no. 4: 33–36, 10 fig.

Frost injury generally occurs on clear still nights. Various methods of protection are discussed. Heating is the most practicable method. Proper preparation is urged. Heating has saved many thousands of dollars, although comparatively new.

***Brackett, G. B.**
Prevention of frost injury to fruit crops. U. S. Dept. Agr. Yearbook, **1909:** 357–364, 1 fig., 1 pl.

Frost damage and protection by explosives, smudges, and heating devices are discussed. Methods of heating with coal and with oil are described, and the cost of each given. Frost injury can be prevented. Methods of procedure are suggested. Published Weather Bureau records show probability of frost occurrence in any region.

***Cox, Henry J.**
Frost and temperature conditions in the cranberry marshes of Wisconsin. U. S. Weather Bur., Bul. **T**, 121 p., incl. maps, diagr., tables, 31 fig.

Cranberry growing in Wisconsin and the necessity of protection from frost are discussed. Flooding is described as a method of protection. The occurrence of low temperatures is also discussed and the frost problem is presented. The effects of exposure, soil, vegetation, and moisture on surface temperatures are explained. Various methods of protection and the incidental disadvantages of each are discussed. For frost forecasting, soil temperatures are important. Careful and continued work is necessary for protection.

Degrees of cold which will kill fruit buds.
Better fruit, **5**, no. 4: 40, 4 fig. (Quoted from Wenatchee Republican.)

The susceptibility of peaches and apples to frost damage at different stages of development is discussed.

Henry, Alfred J.
Variations of temperature and pressure at summit and base stations in the Rocky Mountain region. Mt. Weather Observ. Bul., 1910, **3:** 201–225, 5 fig.

Data for summit and base stations in the Rocky Mountain region of Colorado are discussed by hours and months. The relation of the vertical temperature gradients to cyclones and anticyclones is considered. The relation of air movement to temperature conditions is discussed.

Herrmann, Charles F. von.
How farmers may utilize the special warnings of the Weather Bureau. U. S. Dept. Agr. Yearbook, **1909:** 387–398.

Use of frost and cold-wave warnings, pp. 390–396.
When crops are extended beyond their normal limits, or when great financial gain results from growing crops outside the normal time, artificial protection is necessary. Frost and frost regions are explained. Methods of protection for special crops are outlined.

Herrick, R. S.
Winter and frost injuries to fruit trees. Colorado agr. exp. sta. Bul. **170:** 12–19, 2 fig.

The kinds and causes of winter killing at very low temperatures, the methods of protecting the trees are discussed, and the effect of spring frost on fruit and leaves. Methods of protection are also summarized. If temperature can be kept above 29°F., damage will not result.

Meyer, Lewis.
Orchard heating in Grand Valley, Colorado. Better fruit, **5**, no. 4: 27–29, 6 fig.

Smudge pots or heaters have proved successful, but protection must be carried out in a systematic manner to be successful. Fires must be started before the temperature is too low.

Mitchell, A. J.
Effects of low temperatures on citrus trees and fruits. Mo. weather rev., 1910, **38:** 16–17, 1 fig.

The conditions of frost occurrence in Florida, and the results of the cold wave of December, 1909, are discussed. Temperatures of 25°F. will cause no harm to trees under normal conditions, but such temperatures for 4 to 6 hours will damage fruit. Temperatures of 20°F. will seriously injure trees. Heating will prevent damage.

Paddock, Wendell, & Whipple, Orville B.
Fruit growing in arid regions (New York: Macmillan). **xx**+395 p., 98 fig. "Frost injuries, secondary bloom, and frost protection," chap. **19**, pp. 324-354, figs. 87-96.

Frost injury occurs at variable temperatures. The characteristics of frost injuries and the value of the second-crop bloom and its fruit are discussed. Protection is regarded as insurance. Natural protection by location and its limitations are explained. Methods of artificial protection are discussed as follows: Retarding the blooming period, use of water, smudging, and heating. Coal and oil and the types of burners are compared. The necessary equipment is listed and its probable cost stated. The temperatures at which heaters should be lighted are discussed.

Rhodes, Robert H.
Graphic story of frost fighting in Colorado. Better fruit, **5**, no. 4. p. 30-32, 5 fig.

A vivid popular description of a night's work protecting peaches from damage.

Wells, Edward L.
Relation of Weather Bureau to horticulture. Better fruit, **5**, no. 4. p. 44-46.

The methods of distributing frost forecasts in various fruit districts are described.

Whipple, O. B.
Effect of freezing on buds, bloom, and fruit. Better fruit, **5**, no. 6. p. 20-22, 6 fig.

Knowledge of exact temperatures dangerous to buds, bloom, and fruit is essential to prevent waste or loss. Character of freezing damage is discussed. Dangerous temperatures at different stages of development are given.

Whipple, O. W.
Protection of fruit crops from frost injury. Better fruit, **5**, no. 4. p. 17-19, 8 fig.

Advantage of protecting against frost is now proved. Various methods of protection are discussed. Heating is the most recent and best method. Oil is usually the most satisfactory fuel. The whole community should cooperate.

1909.

Bartlett, James L.
Frosts in Wisconsin: occurrence, prediction, and methods of prevention. Univ. Wisconsin Bul. **290** (University extension series, **1**:39-82. incl. tables, 9 pl.).

The nature of frost and the conditions of its occurrence are discussed. Records of frost occurrence in Wisconsin are given. Methods of observation and forecasting are described, and frost damage and the possibilities of protection in Wisconsin are discussed.

Howard, W. L.
Protecting orchards against frosts and freezes. Missouri agr. exp. sta., Circ. of inform. **35.** 10 p.

Smudging has been successful in Europe in preventing loss of heat by radiation, but heating has met with more favor in the United States. Experiments in Missouri are described and directions given for the use of heaters. Heating is necessary after peach and apple buds open, whenever the temperature falls below the danger point which varies with the stage of development. By using from 75 to 100 pots an acre it is nearly always possible to raise the temperature enough to save the crop in Missouri.

Thiessen, Alfred H.
Smudge pot test [at Salt Lake City]. Mo. weather rev., 1909, **37**: 658-659.

In the absence of wind temperature was raised 4.7 degrees (F.) under rather unfavorable conditions. With a slight wind the increase was very much less.

1908.

Milham, Willis I[sbister].
A two years' study of spring frosts at Williamstown, Mass. Mo. weather rev., 1908, **36**:250-254, 1 fig.

Predictions and characteristics of spring frosts are discussed. Spring frosts may occur until the first of June on clear nights with northwest wind. Plant temperatures are lower than air temperatures. Temperature variation over a limited area may be several degrees. At Williamstown the minimum temperature of vegetation in the open averages 11°F. lower than the shelter minimum.

1906.

Garriott, Edward B.
Cold waves and frost in the United States. U. S. Weather Bur. Bul. **P.** 22 p., 328 charts.

A chronological statement of the more important cold periods which have been experienced in the United States is given. Charts showing the meteorological conditions preceding and accompanying the principal cold waves and frosts from 1888 to 1902 are presented.

1905.

Mead, Theodore L.
A frost-proof orange orchard. Country life in America, **7**:367-369, illus.

A cloth-topped shed over an orange grove and a method of heating by a spray system of irrigation with artesian water at 70°F. is described. A temperature of 48°F. can be maintained inside when that outside is 18°F.

1904.

Cline, I[saac] M.
Irregularities in frost and temperatures in neighboring localities. *In* Third Convention of Weather Bureau officials, Proc., p. 250-253.

During frost the temperature varies locally in a manner which can not be explained by air drainage. This is probably due to differing radiation conditions, probably dust is important. There is also different susceptibility of plants at different times. Different soil conditions are also important.

1903.

McAdie, Alexander G.
The Climatology of California. U. S. Weather Bur. Bul. **L**, 270 p., incl. tables, 31 fig. (incl. pl. I-VI), 12 charts: "Frost," pp. 227-237, incl. table, figs. 13-19.

The losses of fruit crops by frost is very important in California. The nature of frost is discussed. The work of the Weather Bureau in forecasting frost in California is described. Methods of protecting against frost damage are outlined in groups based upon the physical principles involved. These are grouped as follows: Methods based on mixing the air, methods based on warming the air, methods based on cloud or fog formation, methods based on irrigation. Of these, warming the air and fog formation are the most satisfactory. A list of the last frost in spring and the first frost in autumn for stations in California in 1899 is given.

1902.

Lelong, B. M.
Culture of the citrus in California . . . Revised by the California State Board of Horticulture. Sacramento, 1902. "Frost protection," pp. 155-160.

A report by a committee of the Riverside Horticultural Club is quoted. The conclusions of the committee are (1) that the temperature can be raised by dry heat; (2) that radiation may be lessened by moist smudges; (3) that raising the dew-point seems impracticable; (4) that covering will prevent damage, but is too expensive; (5) that windbreaks are partly effective; (6) that severe cold is confined to a thin surface layer; (7) that heating is wholly practicable. Experiments made with lath roofs are described.

1896.

Webber, Herbert J.
The two freezes of 1894-95 in Florida, and what they teach. U. S. Dept. Agr. Yearbook, **1895**:159-174, fig. 16-22, pl. 3.

These freezes caused very serious damage. Methods of lessening damage are discussed. The methods of treatment of trees to help recovery are described. Pineapple plants entirely recover from freezes after one year. Large bodies of water afford great protection to citrus trees in the immediate vicinity.

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New Mexico.
1914. Garcia & Rigney.
1910. Brackett: *Prevention of frost injury* (Better fruit, **5**: no. 4).
1910. Brackett: *Prevention of frost injury* (U. S. Dept. Agr. Yearbook, **1909**).

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SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR OCTOBER, 1915.

By H. C. FRANKENFIELD, Professor of Meteorology.

[Dated: U. S. Weather Bureau, Washington, Nov. 2, 1915.]

GENERAL PRESSURE DISTRIBUTION OVER THE UNITED STATES AND CANADA, INCLUDING THE SANDWICH AND ALEUTIAN ISLANDS, ALASKA, AND THE WESTERN PORTION OF THE MIDDLE ATLANTIC OCEAN.

There were no marked departures from the normal pressure at Honolulu during the month. The barometer was somewhat low from the 2d to the 8th, inclusive, moderately high on the 10th, and again moderately low on the 12th–13th. Thereafter nearly normal pressure prevailed until the 27th, when there was a rise that lasted until the 30th, reaching its crest on the 28th. Over the Aleutian Islands, as indicated by the observations at Dutch Harbor, pressure was generally and decidedly above the normal during much of the month, with a principal crest of 30.56 inches on the 4th, another of 30.30 inches on the 17th, and another of 30.36 inches on the 23d. There were also two pronounced depressions—one on the 14th, when the barometer reading was 28.96 inches, and another on the 31st, with a barometer reading of 29.06 inches. The normal reading for the month is 29.65 inches. Over northern Alaska pressures were considerably above the normal during the first decade of the month, after which there was a general and quite well marked depression until the 17th, when another rise set in that continued until the 26th, followed by a moderate fall thereafter. Over southern Alaska pressure was high during the first decade of the month, but generally low thereafter, with the lowest reading on the 20th, when the barometer at Sitka read 28.96 inches, i. e., 0.79 inch below the normal. Pressure was also abnormally low on the 28th and 31st at Sitka.

The Alaskan high pressure of the first decade of the month extended quite generally through the United States and Canada, but the depressions that prevailed over southern Alaska did not extend in marked form below the Canadian boundary, except at the end of the month. As a general rule pressure was somewhat above normal over the United States during the month.

A general depression of moderate character covered the Caribbean Sea and the West Indies on the 28th and 29th and extended into southern Florida and the adjacent Gulf and ocean. No definite center of disturbance was located, however, and by the 31st pressure was rising generally, though slowly.

Since the 6th day of the month reports had been received by radio service from Petropavlovsk, Kamtchatka, latitude 53° 00′ north, longitude 158° 39′ east, and Anadyr, Bering Sea, latitude 64° 34′ north, longitude 175° 35′ east. These reports are received through the courtesy of the Russian Government.

STORM WARNINGS.

On the morning of the 1st moderately high pressure over the lower St. Lawrence Valley and New England, with a disturbance of fair character over eastern Kentucky, and a moderate secondary disturbance over southern Virginia, indicated the approach of high easterly winds on the Middle Atlantic and New England coasts and northeast warnings were accordingly ordered at 10 a. m. from Baltimore to Portland, Me., and southwest warnings from Fort Monroe, Va., to Hatteras, N. C. Both disturbances moved slowly northeastward and during the succeeding 24 hours there were easterly gales on the Middle Atlantic and southern New England coasts with a maximum velocity of 68 miles an hour from the east at Delaware Breakwater, Del. At 10:30 a. m. of the 1st northeast storm warnings were also ordered on the Lower Lakes and southern Lake Huron, but the winds that followed were only fresh and the warnings were lowered at 9:30 p. m. On the morning of the 2d the original disturbance was over western New York, while the secondary one was off the New Jersey coast with somewhat increased intensity, and northeast storm warnings were therefore continued at 10:30 a. m. from Narragansett, R. I., to Portland, Me. Northeasterly winds continued during the day on the southern New England coast with a maximum velocity of 60 miles an hour at Nantucket, Mass. There were no other storms of great consequence during the month, although a series of lows passed over the northern portion of the country necessitating storm warnings at various times. In no instances, however, were the high winds resulting from these storms widespread or of unusual velocity. The only gale of consequence that occurred was on Lake Superior on the 7th, at which time there was a pronounced northwestern disturbance over that section with a cold high area of considerable magnitude to the westward. During this storm the wind at Duluth reached a velocity of 52 miles an hour from the west and northwest, and at Whitefish Point, Mich., 46 miles an hour from the east, and the high winds were accompanied by snow flurries. Storm warnings were ordered for this storm on the morning of the 7th.

FROST WARNINGS.

There was but one principal frost period during the month in the Washington district. On the morning of the 6th pressure was rising rapidly in the Northwest following a disturbance that at that time extended from the Texas Pan Handle to northern Minnesota. The disturbance moved northeastward and the high area followed with increasing magnitude and with temperatures that fell much below the freezing point through the northwestern country. On the morning of the 7th the crest of the high-pressure area was over southeastern Montana, with the low center over Lake Superior, and frost warnings were therefore ordered for Tennessee, the Ohio Valley, and northern Indiana. On the morning of the 8th frost occurred as forecast and was heavy in many localities. At this time the western high-pressure area was still increasing in magnitude, with temperatures about 10° below the freezing point, and general frost warnings were therefore issued for the Ohio Valley, Indiana, Ohio, the interior of Pennsylvania, Maryland, the District of Columbia, the interior of New Jersey and Virginia, central and western North Carolina, central and

northwestern South Carolina, and central and northern Georgia. Warnings of freezing temperature were also issued for lower Michigan. On the morning of October 9 it was found that the frost had occurred as forecast and had extended in very light form as far south as central Alabama. The high-pressure area now covered the Great Central Valleys, and it was therefore necessary to issue warnings of heavy to killing frosts, or freezing temperatures, for the entire district north of the thirty-fifth parallel, and warnings of light frost were also ordered for the northern portions of the East Gulf States. Frost occurred as indicated, except along the Middle Atlantic coast. There was no other frost of consequence until the morning of the 25th, when heavy to killing frosts occurred in portions of the Middle Atlantic States. As the season was late and heavy frost had already occurred over this area, no warnings were issued.

DISTRICT WARNINGS DURING OCTOBER.

Chicago forecast district.—On the morning of October 3 frost warnings were issued for southern North Dakota, South Dakota, western Nebraska, and eastern Wyoming. Frost occurred the following morning in western Nebraska and eastern Wyoming, but continued cloudiness prevented frost formation in the Dakotas. By the morning of the 4th a strong high-pressure area was advancing eastward over the eastern slope of the Rockies and the Plains States, and frost warnings were issued for the entire district east of the Rockies, except Illinois and eastern and southern Missouri. These warnings were fully verified in all sections, except near Lake Superior, in part of southern Wisconsin and southeastern Montana, where there was considerable cloudiness. In addition there was light frost in northeastern Missouri and southwestern Illinois. Warnings of frost were issued on the 5th for southern and central Wisconsin, eastern Iowa, Illinois, and Missouri. Frost occurred as predicted, except in northwest Missouri, northeast Iowa, and extreme western Wisconsin, the failure in these sections being due to the rapid southeastward advance of an area of low pressure from the northwest.

This disturbance was followed by another high-pressure area of considerable strength, and on the morning of the 7th warnings of frost were issued for Kansas and Nebraska and frost or freezing temperature for eastern Montana, North and South Dakota. These warnings were fully verified, except in southern Kansas. By the morning of October 7 the pressure had increased to 30.52 inches at Miles City, Mont., and high pressure covered the entire trans-Missouri region, so that warnings of heavy frost were issued for Illinois, Iowa, Missouri, and Kansas, and heavy frost or freezing temperature for Wisconsin, Minnesota, South Dakota, and Nebraska. Frost, in most sections heavy to killing, occurred generally on the morning of the 8th, except in part of Wisconsin and northeastern Iowa, where cloudiness continued. Snow was falling at some Wisconsin stations. As the pressure was abnormally high (30.68 in. at Pierre, S. Dak.), with low temperatures over the Plains States and upper Missouri Valley on the morning of the 8th, warnings of heavy frost were issued for Illinois, Missouri, Kansas, and eastern Nebraska, heavy frost and freezing temperature for Wisconsin, Minnesota, and Iowa, and a severe freeze in the cranberry marshes of Wisconsin. These warnings were fully verified. There was a severe freeze in northern Illinois, Iowa, and Wisconsin, and much damage was done to the immature corn, which was very late on account of the abnormally cool summer. A temperature of 4°F. was reported at Mather, Wis., and 6° at Grand Rapids, Wis., in the cranberry bogs, and these are probably the lowest readings of record so early in the season. Frost warnings were again issued on the 9th for central and southern Illinois, extreme southeastern Wisconsin and extreme eastern Missouri, with freezing temperature in the Wisconsin cranberry marshes. However, a marked disturbance which moved rapidly southeast from the Canadian Northwest to the upper Missouri Valley, caused a rise in temperature in the upper Mississippi Valley, so that no frost was reported on the morning of the 10th. In the cranberry marshes of Wisconsin there was a hard freeze.

A warning of light frost was issued for western Missouri on the 13th, but failed of verification, and one issued for Kansas on the 25th was verified in the southern half of the State only, light frost being reported from southwestern Missouri also. On the 26th a warning of frost for this portion of Missouri was issued, but none was reported on the following morning.

Killing frosts had occurred at all stations in this forecast district during the first decade of the month, except in southern Illinois, Missouri, and Kansas, so that later warnings were confined to these States.—*Chas. L. Mitchell, Assistant Forecaster.*

Denver forecast district.—No warnings of general importance were issued. The frost warnings were of local interest only.—*F. H. Brandenburg, District Forecaster.*

New Orleans forecast district.—No storm occurred which called for warnings of any importance during the month.

Frost occurred on October 8 in Oklahoma, Arkansas, and northern Texas; for this warnings were issued on the morning of the 7th.—*I. M. Cline, District Forecaster.*

San Francisco forecast district.—No important warnings were issued during the month.—*G. H. Willson, District Forecaster.*

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS OF OCTOBER, 1915.

By ALFRED J. HENRY, Professor in Charge of River and Flood Division.

[Dated: Washington, D. C., Dec. 2, 1915.]

No floods of consequence occurred in the larger trunk streams, although a number of local floods in widely separated rivers occurred, as may be seen from the table below. These floods were due in a great majority of cases to heavy rainfall over the watersheds of the several rivers that were in flood. The high stages were successfully forecast by the local officials in charge of the respective river districts. As a rule, damages were nominal, except in the case of the Red River floods, where rather heavy damage to levees, roads, etc., appears to have been sustained.

Floods in the United States, October, 1915.

River.	Station.	Flood stage.	Above flood stage.		Crest.	
			From—	To—	Stage.	Date.
		Feet.			*Feet.*	
Mississippi	Hannibal, Mo	13.0	3	4	13.1	3,4
Illinois	La Salle, Ill	18.0	1	1	18.0	1
North Canadian	Canton, Okla	3.0	17	17	3.8	17
Red	Arthur City, Tex	27.0	19	21	29.8	20
Do	Fulton, Ark	28.0	23	28	30.2	26
Trinity	Dallas, Tex	25.0	19	21	29.3	20
Nueces	Cotulla, Tex	13.6	19	19	13.6	19
West Pearl	Pearl River, La	13.0	4	11	15.1	5
Santee	Rimini, S. C	12.0	8	12	12.9	9,10
Do	Ferguson, S. C	12.0	10	14	12.6	12,13
Broad	Carlton, Ga	11.0	16	16	11.0	16
Staunton	Randolph, Va	21.0	2	3	24.8	3
Roanoke	Weldon, N. C	30.0	4	4	32.0	4
James	Buchanan, Va	15.0	1	1	16.0	1
Do	Columbia, Va	18.0	2	3	23.1	2
Do	Richmond, Va	10.0	2	3	11.7	3
Little Kanawha	Glenville, W. Va	22.0	1	1	24.0	1
Do	Creston, W. Va	20.0	....	....	19.8	2

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

MEAN LAKE LEVELS DURING OCTOBER, 1915.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Nov. 5, 1915.]

The following data are reported in the Notice to Mariners of the above date:

Data.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during October, 1915:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	602.75	579.81	571.99	245.17
Above or below—				
Mean stage of September, 1915	+0.26	−0.15	−0.21	−0.28
Mean stage of October, 1914	+0.02	−0.48	−0.07	−0.42
Average stage for October, last 10 years	+0.09	−0.75	−0.14	−0.70
Highest recorded October stage	−0.81	−3.13	−1.71	−2.64
Lowest recorded October stage	+1.17	+0.21	+1.19	+1.50
Average relation of the October level to:				
September level	0.0	−0.2	−0.3	−0.4
November level	+0.2	+0.3	+0.3	+0.2

SECTION V.—SEISMOLOGY.

SEISMOLOGICAL REPORTS FOR OCTOBER, 1915.

By W. J. HUMPHREYS, Professor in charge of Seismological Investigations.

[Dated: Weather Bureau, Washington, D. C., Dec. 1, 1915.]

TABLE 1.—*Noninstrumental earthquake reports, October, 1915.*

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA.								
	H. m.		° ′	° ′			M. s.			
1	15 26	Livermore	37 40	121 45	2	1				E. G. Still.
	15 26	Oakland	37 47	122 15	2	1	2		Chandeliers swayed	Chas. Burckhalter.
	15 26	Petaluma	38 15	122 38	4-5	2				John Landis.
	15 26	San Francisco	37 48	122 26	3	1	5	Rattling		U. S. Weather Bureau.
	15 26	do	37 47	122 26						Dominican Sisters.
	15 26	San Jose	37 20	121 54	2	1	3			U. S. Weather Bureau.
3	1 50	Camptonville	39 23	121 04	4	1	30			Elmer Hall.
3	6 56	Alturas	41 32	120 30						C. B. Towle.
	6 56	Bridgeport	38 18	119 15	4	2				A. F. Scott.
	6 56	Camptonville	39 23	121 04	4	1				Elmer Hall.
	6 56	Chester	40 18	121 15	2	2				G. W. Olsen.
	6 56	Chico	39 40	121 40	2	2	30			R. L. Beagles.
	6 56	Coleville	38 36	119 32	4	1				F. W. Chichester.
	6 56	Colgate	39 22	121 14	2	1				M. P. Werry.
	6 56	Colusa	39 12	122 00	5	2				C. D. McComish.
	6 56	De Sabla	39 50	121 37		1	15	Rattling		C. B. Adams.
	6 56	Donner	39 17	120 21		1	5			E. F. Stewart.
	6 56	Fort Bidwell	41 51	120 08	4-5	1	1 00		Many awakened by shock	C. R. Decious.
	6 56	Fresno	36 43	119 49	3	2	10		Windows rattled	U. S. Weather Bureau.
	6 56	Gold Run	39 12	120 50	2	1				O. E. Collins.
	6 56	Lathrop	37 51	121 17	4	1	20			O. A. Seamands.
	6 56	Lindsay	36 13	119 06	2					Basil Prior.
	6 56	Lonoak	36 20	122 00	2	1				M. L. Griffin.
	6 56	McCloud	41 17	122 09	3	1			Windows rattled	F. A. Thomas.
	6 56	Markleeville	38 42	119 46	1	1	20	Rumbling		Mary Thornburg.
	6 56	Magalia	39 45	121 36		1	1 00			H. S. Conan.
	6 56	Nevada City	39 17	121 01						S. W. Marsh.
	6 56	Oroville	39 29	121 39						E. D. Fairchild.
	6 56	Sacramento	38 35	121 30	5	3	18			U. S. Weather Bureau.
	6 56	San Jose	37 20	121 54	5	1	5		Clocks stopped	U. S. Weather Bureau.
	6 56	Stockton	37 57	121 22	2	1				E. P. Higby.
	6 56	Tallac	38 56	120 03						W. D. Sloan.
	6 56	Woodfords	38 47	119 49	5	2	14	Faint		G. P. Merrill.
8	3 02	Sebastopol	38 23	122 46	3	1	5	Rumbling	A few awakened by shock	E. H. Parnell.
8	5 25	Oakland	37 47	122 15	4	3	1	Rattling		Chas. Burckhalter.
	5 25	Petaluma	38 15	122 38	4	1		Rumbling		John Landis.
	5 25	Sebastopol	38 23	122 46	3	1				E. H. Parnell.
	5 25	San Francisco	37 48	122 27	4	2	10			U. S. Weather Bureau.
	5 25	Tamalpais	37 56	122 35	3	1	10			U. S. Weather Bureau.
8	5 35	Oakland	37 47	122 15	3	1	2	Rattling		Chas. Burckhalter.
	5 35	San Francisco	37 48	122 27	2	1	2			U. S. Weather Bureau.
8	21 20	Petaluma	38 15	122 38	4	1				John Landis.
10	5 06	Seven Oaks	34 05	117 12	4-5	1	2			E. N. Munns.
20	8 15	New Meadows	44 57	116 18	2	1				Lee Highley.
22	6 18	Oakland	37 47	122 15	3	1	2	Rattling		Chas. Burckhalter.
24	5 26	Holcomb Valley	34 17	117 05						J. McHenry.
		KENTUCKY.								
26	7 40	Mayfield	36 45	88 38	5	1	3	Rumbling		W. L. Hale.
		MICHIGAN.								
4	14 02	Calumet	47 13	88 26	3	1	1		Shook pictures off walls	E. S. Grierson.
		NEVADA.								
2	23 41	Fallon	39 30	118 48	2	1	10			E. W. Curtis.
	23 41	Gerlach	40 38	119 24	6	1	1 00		Clocks stopped	W. T. Dauterman.
	23 41	Reno	39 32	119 49	1	1	4			U. S. Weather Bureau.
	23 41	Unionville	40 28	118 09	4	1				Jane Hatton.
	23 41	Virginia City	39 14	119 40	1	1				F. O'Connor.
	23 41	Yerington	38 58	119 11	3		2			Carlton Hieronymus.
3	1 50	Austin	39 31	117 05	4	1	10			U. S. Forest Service.
	1 50	Fallon	39 30	118 48	5	1	30	Faint	Some clocks stopped	E. W. Curtis.
	1 50	Reno	39 32	119 49	3	1	4		Few clocks stopped	U. S. Weather Bureau.
	1 50	Sand Pass	40 15	119 48	5	1	30			R. R. Mott.
	1 50	Unionville	40 28	118 09	5	1				Jane Hatton.
	1 50	Virginia City	39 14	119 40	5	1			Chandeliers swayed	F. O'Connor.
	1 50	Yerington	38 58	119 11	2	1	2			Carlton Hieronymus.
3	6 56	Arthur	40 32	115 21	7	2	17	Loud	Some walls cracked	Isaac Woodhouse.
	6 56	Austin	39 31	117 05	5	1	30	Loud		U. S. Forest Service.
	6 56	Battle Mountain	40 40	116 57			22	Rumbling		C. C. Carlson.
	6 56	Beowawe	40 36	116 29	6			Rumbling		L. Grebene.

TABLE 1.—*Noninstrumental earthquake reports, October, 1915*—Continued.

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		NEVADA—continued.								
	H. m.		° ′	° ′			M. s.			
3	6 56	Caliente	37 35	114 26			30			J. L. Denton.
	6 56	Carson City	39 11	119 48	3-4	1	30			Annie Martin.
	6 56	East Cherry Creek	39 43	114 51	4	1			Shook beds violently	J. H. Leishman.
	6 56	Elko	40 51	115 45	5	6				Western Pacific Co.
	6 56	Eureka	39 23	115 59	7	8		Rattling		Clay Simms.
	6 56	Fallon	39 30	118 48	7					E. W. Curtis.
	6 56	Golconda	40 58	117 30	7					E. W. Merrill.
	6 56	Golconda	40 58	117 30	7	4		Rumbling	Some walls cracked	D. H. Pettingell.
	6 56	Gold Creek	41 42	115 43	6	2	1 15	Rumbling	Clocks stopped	U. S. Forest Service.
	6 56	Halleck	40 54	115 28	6	3				R. C. Simms.
	6 56	Las Vegas	36 09	115 09	3	1	2			C. P. Squires.
	6 56	Lida	37 21	117 24	5	2	20			L. F. Detwiler.
	6 56	Lovelocks	40 11	118 30	8		30	Rumbling	Water tanks wrecked	W. C. Watson.
	6 56	McGill	39 19	114 48	6	2	1 00		Clocks stopped	R. E. Middagh.
	6 56	Millett	39 01	117 15	7	3		Rumbling	Plaster fell	F. J. Jones.
	6 56	Mina	38 24	118 06	5	1				G. L. Eckley.
	6 56	Mount Rose	39 16	119 55	6	1				Prof. Baker.
	6 56	North Fork	41 24	115 50	5-6	5		Rumbling		Charles Pratt.
	6 56	Rebel Creek	41 39	117 45	5			Rumbling		F. Whitaker.
	6 56	Reno	39 32	119 49	6	1	45	Rumbling		U. S. Weather Bureau.
	6 56	San Jacinto	41 53	114 42	5	2	20			J. S. Parmley.
	6 56	Sharp	38 07	115 28	5	2	4			F. A. Sears.
	6 56	Tecoma	41 14	114 05	5	2	30	Rumbling		W. E. Smith.
	6 56	Tonopah	38 04	117 14	6	1	10		Clocks stopped	U. S. Weather Bureau.
	6 56	Unionville	40 28	118 09	8			Rumbling	Cracks formed in earth	Jane Hatton.
	6 56	Virginia City	39 14	119 40	4	3				F. O'Connor.
	6 56	Vya	41 34	119 53	2	3		Faint		W. N. Lord.
	6 56	Winnemucca	40 58	117 43	8	1	30		Many thrown out of bed	U. S. Weather Bureau.
	6 56	Yerington	38 58	119 11	5-6	3	6		Some clocks stopped	Carlton Hieronymus.
3	8 45	Garrison			4	1	30			E. M. Smith.
15	20 21	Fallon	39 30	118 48	2	1	5			E. W. Curtis.
	20 21	Gerlach	40 38	119 24	4	1	1 00			W. T. Dauterman.
	20 21	Winnemucca	40 58	117 43	3					U. S. Weather Bureau.
20	2 34	Fallon	39 30	118 48	3	1	10			F. B. Headley.
23	4 09	Fallon	39 30	118 48	2	1	5			F. B. Headley.
		NORTH CAROLINA.								
29	5 45	Asheville	35 36	82 32	4	1	15		Shook buildings	U. S. Weather Bureau.
		OKLAHOMA.								
8	16 50	Muskogee	35 45	95 16	3	1	10	Rumbling	(Explosion?)	L. B. Smith.
		OREGON.								
3	6 56	Baker	44 46	117 50	6	1	30		A few walls cracked	U. S. Weather Bureau.
	6 56	Beckley	42 40	119 05	4-5		10		Many awakened by shock	O. T. Stuart.
	6 56	Burns	43 35	119 04	3	1				J. C. Welcome, jr.
	6 56	Lakeview	42 12	120 20	4	2				C. C. Gott.
	6 56	Sunrise Valley	43 08	118 09	4	2				W. R. Gardner.
	6 56	Valley Falls	42 32	120 15		1				E. H. Meyer.
20	7 30	Fruita	45 20	116 46		1				H. J. Neiman.
		SOUTH DAKOTA.								
23	7 05	Kadoka	43 48	101 30	5	1		Loud	Earth cracked open. (Collapse of cavern roof?)	John Bush.
		UTAH.								
2	23 41	Salt Lake City	40 46	111 54	1-2	1				U. S. Weather Bureau.
3	1 50	Salt Lake City	40 46	111 54	2	2	4			U. S. Weather Bureau.
3	6 56	Corinne	41 34	112 07	2	1				A. C. Murphy.
	6 56	Garland	41 45	112 11	4	1			Dishes rattled	J. W. Roberts.
	6 56	Grantville	40 37	112 27	4	1				Monto Barrus.
	6 56	Grouse Creek	41 43	113 55	5	3	5	Rumbling		Philip Paskett.
	6 56	Kelton	41 45	113 06	5	2	30			F. W. Clock.
	6 56	Lucin	41 22	113 54	6	1	30		Some clocks stopped	E. C. Puryear.
	6 56	Midvale	40 36	111 53	5	2	5	Rumbling		E. D. Camomile.
	6 56	Modena	37 48	113 54	2					Mr. Wood.
	6 56	New Castle	37 40	113 30		1	3			R. E. Griffiths.
	6 56	Ogden	41 14	111 58	5	1		Rumbling		R. E. Shorten.
	6 56	Promontory Point	41 13	112 27		1				M. H. Compson.
	6 56	Reed	38 35	113 10	5	1	10			D. N. Hickman.
	6 56	Salt Lake City	40 46	111 54	6	1	30	Rumbling	Some clocks stopped	U. S. Weather Bureau.
	6 56	Snowville	42 00	112 43	4-5	2				J. C. Cutler.
	6 56	Standrod	42 00	113 26	5	1				T. B. Jones.
4	12 00	Clarkston	41 55	112 04	2	1		Rumbling		W. J. Griffiths.
5	8 00	Ibapah	40 04	114 00	6	1		Rumbling	Clocks were stopped	A. B. Reagon.
25	17 13	Joseph	38 37	112 18	1-2	1	3			S. E. Henri.
		WYOMING.								
17	3 06	Yellowstone Park	44 20	110 20	2	1	1			C. M. Moore.
		PORTO RICO.								
11	19 35	Isabela	18 30	67 04	5	1	4			W. M. Orr.
	19 35	Lares	18 33	66 55	5	1	5	Rumbling		Paul Vilella, jr.
	19 35	San Juan	18 29	66 07	5	1			Some clocks stopped	U. S. Weather Bureau.

TABLE 2.—*Instrumental reports, October, 1915.*

[Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.]

[For significance of symbols see this REVIEW, June, 1915, p. 289.]

Alaska. *Sitka.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. J. W. Green.

Lat., 57° 03′ 00″ N.; long., 135° 30′ 06″ W. Elevation, 15.2 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: E: V 10, T_0 17.4; N: V 10, T_0 15.6

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*Km.*	
Oct. 3		P_E	6 58 09	5				
		P_N	6 58 12	9				
		S_E	7 01 57	12				
		S_N	7 01 58	16				
		L_N	7 04 33	22				
		L_E	7 04 42	24				
		M_N	7 04 52	17		*5,850		
		M_E	7 05 02	20	*4,650			
		C	7 14 00	10				
		F_N	8 15 00					
		F_E	8 28 00					

* Trace amplitude.

Arizona. *Tucson.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat., 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: E: V 10, T_0 16; N: V 10, T_0 19.6

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			H. m. s.	*Sec.*	μ	μ	*Km.*	
Oct. 2		eP	23 44 35	3				
		M	23 45 55	5	60	20		
		F	23 51 00					
3		eP	1 52 56	4				
		L	1 53 46	6				
		M	1 53 56	7	330	250		
		C	1 56 19	6				
		F	2 08 00	6				
3		P_E	6 55 40	4				
		P_N	6 55 22	5				
		L_N	6 58 21	11				
		L_E	6 58 25	7				
		M_E	6 59 39	9	430			Stylus went off paper.
		M_N	6 59 58	5		490		
		C_N	7 06 18	7				
		C_E	7 13 18	10				
		F_N	8 11 00					
		F_E	8 50 00					
12		P_E	2 24 14	4				No distinct record on N-S.
		M	2 24 44	5	10			
		F	2 29 29					
28		P	16 05 13	4				
		M_N	16 05 50	3		20		
		M_E	16 06 55	4	30			
		F	16 11 00					

California. *Berkeley.* *University of California.*

Lat., 37° 52′ 16″ N.; long., 122° 15′ 37″ W. Elevation, 85.4 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Mount Hamilton.* *Lick Observatory.*

Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Point Loma.* *Raja Yoga Academy.* F. J. Dick.

Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.

Instrument: Two-component, C. D. West seismoscope.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 4					*600	*600		All of these tremors occurred at unknown hours being recorded during the 24 hours preceding 15h on dates given. No perceptible shocks were felt.
8					*200	*200		
10					*400	*600		
12					*300	*300		
15					*400	*600		
16					*300	*300		
17					*400	*600		
20					*200	*100		
22					*200	*200		
25					*200	*300		
29					*100	*100		

* Amplitude on instrument.

California. *Santa Clara.* *University of Santa Clara.* J. S. Ricard, S. J.

Lat., 37° 26′ 36″ N.; long., 121° 57′ 03″ W. Elevation, 27.43 meters.

(See record of the Seismographic Station, University of Santa Clara.)

Colorado. *Denver.* *Sacred Heart College.* Earthquake Station. A. W. Forstall, S. J.

Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.

Instrument: Wiechert 80 kg., astatic, horizontal pendulum.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 2	I_v	P_E	23 42 00					P not discernible on N-S. Nevada earthquake.
		S_E	23 44 00					
		M	23 45 00	8	25	25		
		F	23 50 00					
3	I_v	M_E	1 53 00	15–20	35			P and S not discernible. Nevada earthquake.
		M_N	1 53 00	1–4		68		
		C	1 56 00					
		F	2 03 00					
3	III_v	L_E	6 56 00	10–12	112			P and S not discernible. Periods of M doubtful, owing to pens jumping off the paper. Amplitudes of M doubtful owing to safety stops—probably larger.
		L_N	6 56 30	10–12		62		
		M_E	6 57 30	8–12	687			
		M_N	6 58 00	8–12		537		
		C	7 19 00	8				
		F	7 48 00					
7								Very small sinusoidal waves at times.
23								Intermittent activity on E-W.

District of Columbia. *Washington.* *U. S. Weather Bureau.*

Lat., 38° 54′ N.; long., 77° 03′ W. Elevation, 21 meters.

Instrument: Marvin (vertical pendulum, undamped. Mechanical registration.)

Instrumental constants.. V 110, T_0 6

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 2	I_r	S	23 56 15					P lost in microseisms. No record obtained on E-W component for this and the next two earthquakes.
		M	23 57 35			18		
		L?	23 57 41					
		M	23 59 50			14		
3		F	0 20 00					
3	I_r	P						P uncertain.
		S	2 04 49					
		M	2 05 45					
		L	2 07 49	14				
		F	2 35 00					

TABLE 2.—*Instrumental reports, October, 1915*—Continued.

District of Columbia. *Washington*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 3	III_r	P	6 59 37				3,360	Many large maxima from 7^h 09^m to 7^h 37^m. Stylus ran off sheet. Severe earthquake in Nevada.
		S	7 04 45					
		L	7 07 29					
		F	8 50 00					
11	I_u	P	2 46 38				5,400	
		S	2 53 42					
		F	3 20 00					
11	II_r	P	19 37 49				2,340	Felt in Porto Rico.
		S	19 41 41					
		M	19 42 40			41		
		L	19 45 19	16				
		F	20 50 00					
12	I_r	P	2 22 42				2,400	
		S	2 26 39					
		L	2 30 05	14				
		F	2 50 00					
22		e	5 08 29					Phases indistinct, lost in microseisms.
		M	5 09 29					
28		e	16 19 00					Phases indiscernible.
		F	16 25 00					

District of Columbia. *Washington. Georgetown University.*

F. L. Tondorf, S. J.

Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W. Elevation, 42.4 meters. Subsoil; decayed diorite.

Instruments: Wiechert 200 kg. astatic horizontal pendulums, 80 kg. vertical.

Instrumental constants:

	V	T_0	ε
E	165	5.4	2.6
N	143	5.2	3.4
Z	*80*	*3.0*	*0*

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 2	I_r	eP_N?	23 55 23					P_E not discernible.
		S_E	23 55 46					
		S_N	23 56 18	5				
		L_N	23 57 19					
		L_E?	23 58 31					
		L_E	23 59 51					No distinct maximum.
3		F_N	0 05 44					
		F_E	0 07 19					
3	I_r	eP_N	1 59 41					S_N and S_E doubtful.
		eP_E	2 01 21					
		L_N	2 05 19	12				
		L_E	2 07 38	9				
		F_N	2 15 20					
		F_E	2 20 19					
3	III_r	eP_E?	6 59 44	5				P masked in microseisms.
		eP_N?	6 59 47	5				
		iS_E	7 04 41	12				Reported in Nevada, Utah, Idaho, and Oregon.
		S_N	7 04 43	10				
		L_N	7 08 45	12				
		M_N	7 09 46	9		102		
		L_E	7 10 01	12				
		M_N	7 10 20	9		150		
		M_E	7 12 41	9	78			
		M_E	7 12 52	9	81			
		F_E	8 46 31					
		F_N	8 48 13					
					VERTICAL. (A_Z)			
		M	*7 10 18*	*9*	**5,500*			
		M	*7 13 30*	*8*	**9,600*			
		F	*7 20 04*					
11	II_r	iP_N	19 37 53	4				
		P_E	19 37 55	4				
		S_N	19 41 51	7				
		S_E	19 42 03	6				
		L_N	19 45 11	9-10				
		L_E	19 45 54	10				
		M_N	19 47 56	10		3		
		M_E	19 48 20	10	2			
		F_E	20 17 08					
		F_N	20 23 13					

*Trace amplitude.

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Wm. W. Merrymon.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

Instrumental constant.. T_0 18.8

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 3		eL	2 05 36					
		M	2 10 00	18	*100			
		F	2 20 00					
3		P	7 01 30					
		L	7 10 12	23				
		M	7 12 24		*6,100			
		C	8 48 06					
		F	10 40 24					
5		P	13 57 18					
		M	14 04 36	19	*500			
		C	14 09 36					
		F	15 04 12					
8		e	15 54 12					
		L	15 59 12					
		M	15 59 42	18	*200			
		C	16 07 06					
		F	16 22 12					
10		eL	6 15 18	23				
		M	6 21 24		*200			
		F	6 37 12					
10		e	10 32 54					
		M	10 37 48	20	*100			
		F	10 43 00					
11		e	16 34 42					
		M	16 41 00		*200			
		F	16 45 18					
11		e	20 14 36					
		M	20 21 42		*400			
		F	21 38 00					
12		e	21 45 48					
		M	21 46 42		*400			
		C	21 50 54					
		F	22 46 30					
23		L	12 15 00	22				
		M	12 20 12		*600			
		C	12 22 42					
		F	12 35 42					

* Trace amplitude.

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′ 58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

Instrumental constants..

	V	T_0	ε
E	177	3.4	4.0
N	205	3.4	3.8

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 2		P	23 41 51					
		P	23 44 00					
		S	23 47 19					
		L?	23 49 18					
		M		10-12	3	6		
3		F	0 08 00					
3		P_E	1 51 57					
		P	1 52 26					
		S	1 55 42					
		S	1 57 24	2- 3				
		L_N	1 57 43	10-15				
		M_N	1 58 27			9		
		L_E	1 59 21	8-10				
		M_E	1 59 41		7			
		F	2 12 00					
3		P	6 57 20		16			
		PM		3- 4	37	7		
		S	7 00 38					
		SM		4- 8	37	22		
		L_N	7 01 51					
		L_E	7 02 05					
		M_N	7 04 00			278		N-S needle thrown from bearings.
		M_E	7 05 10		266			
		F	8 44 00					

TABLE 2.—*Instrumental reports, October, 1915*—Continued.

Kansas. *Lawrence. University of Kansas*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Oct. 11	......	P_E?	19 33 29					Slight tremors preceded first identified primary wave.
		P_N?	19 33 49					Phases very indistinct.
		S_E?	19 39 12	2–3				
		S_N?	19 39 19	2–3				
		P	19 40 03	2–3				
		P_N?	19 42 13					
		S_E	19 45 26	3–5				
		S_N	19 46 01	3–5				
		P_N?	19 47 01					
		L_N	19 48 01	10–20				
		F_N	21 00 00					

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 44′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: E — V 10, T_0 31; N — V 10, T_0 29.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1915.			*H.m.s.*	*Sec.*	*μ*	*μ*	*Km.*	
Oct. 2	......	eP	23 55 36					
		L	23 56 46					
		M	23 56 51		10	10		
		C	24 00 00					
3		F	0 02 00					
3	......	eP_E	2 04 44					
		eP_N	2 04 57					
		M_N	2 05 41	4		10		
		M_E	2 06 56	6	10			
		F	2 20 00					
3	......	P_E	6 59 09	4				
		P_N	6 59 37	4				
		S_E	7 04 17	12				
		S_N	7 04 51	12				
		L	7 09 17	21				
		M	7 10 01	10	392	550		
		C	7 18 00	10				
		F	8 05 00					
11	......	P	19 38 03	3				
		L	19 41 51	11				
		M_E	19 42 00	8	40			
		M_N	19 48 33	12		40		
		C	19 49 00	12				
		F	20 05 00					

Massachusetts. *Cambridge. Harvard University* Seismographic Station. J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instrument: Two Bosch-Omori, 100 kg., horizontal pendulums (mechanical registration).

Instrumental constants: E — V 80, T_0 23, ϵ:1 0; N — V 50, T_0 25, ϵ:1 4:1.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1915.			*H.m.s.*	*Sec.*	*μ*	*μ*	*Km.*	
Oct. 2	......	*O*?						
		e	23 58 12					e in microseisms.
		S	23 59 55	6				N–S component out of commission.
3		L	0 01 22	8–10				
		F	0 05 52					
3	......	*O*?						
		e_E	2 03 17					e in microseisms.
		S	2 06 35					
		L	2 08 50	10–12				
		F	2 25 22					
3	......	*O*?	*6 53 12*				3,780	*O* from S–P by tables furnished by Dr. Klotz.
		eP_E	7 00 06					
		S	7 05 40	22				
		eL	7 10 36					
		M	7 12 11					
		F	8 57 00					

Massachusetts. *Cambridge. Harvard University*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Oct. 11	......	*O*?	*19 23 33*				2,450	Press reports slight shock at San Juan, Porto Rico, at "3:35" p. m. Oct. 11. N–S in operation.
		eP_N	19 38 25	3				
		P_E	19 38 44					
		S	19 42 24	10				
		eL	19 45 22					
		L_N	19 48 51	11–12				
		F	20 40 00					
12	......	e_E	22 19 38					e in microseisms.
		eL?	22 22 00	17–24				No trace on N–S (damped 4:1).
		L	22 28 10	15				
		F	22 43 00					

O=Time at origin.

Missouri. *St. Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation, 12 feet of tough clay over limestone of Mississippi System, about 300 feet thick.

Instrument: Wiechert 80 kg. astatic, horizontal pendulum.

Instrumental constants: V 80, T_0 7, ϵ:1 5:1.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1915.			*H.m.s.*	*Sec.*	*μ*	*μ*	*Km.*	
Oct. 2	I_r	P	23 44 00					
3		F	0 20 00					
3	I_r	P	1 53 12					
		F	2 13 00					
3	III_r	P	6 58 06				2,300	
		S	7 02 06					
		L	7 03 00					
		F	8 42 00					
11	II_r	P_E	19 43 42				2,500	
		S_E	19 49 30					
		L_E	19 50 00					
		F	20 24 00					

New York. *Buffalo. Canisius College.* John A. Curtin, S. J.

Lat., 42° 53′ 02″ N.; long., 78° 52′ 40″ W. Elevation, 190.5 meters.

Instrument: Wiechert 80 kg. horizontal.

Instrumental constants: V 80, T_0 7, ϵ:1 5:1.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Oct. 3	III_r	EP_N	6 58 00					Reported in Nevada, Utah, Idaho, and Oregon.
		eP_E	6 58 30					The L and M waves indicate two distinct earthquakes, arriving two minutes and thirty seconds apart. Two S_E also seem to confirm this conclusion. Second P_E and P_N indistinct.
		S_N	7 03 00					The first shock appeared to come from the SW., the second from the NW.
		iS_E	7 03 30	12				
		iS	7 06 00	15				
		L_N	7 06 00	9		140		
		L_E	7 07 00	10				
		L_N	7 08 00					
		M_N	7 09 00	7		250		
		L_E	7 09 30		155			
		M_E	7 10 00	8	240			
		M_N	7 11 45			180		
		C	7 12 00					
		M_E	7 12 30		305			
		C_E	7 13 00					
		C_E	7 16 00					
		C_N	7 16 30					
		F_E	8 03 00					
		F_N	8 04 00					
11	I_r	eP	19 42 00					Not heard of. Direction doubtful.
		S_E	19 46 30					
		S_N	19 47 00					
		M_N	19 53 00	16				
		M_E	19 53 00	15				
		C_E	19 57 00					
		F_E	20 00 00					

TABLE 2.—*Instrumental reports, October, 1915*—Continued.

New York. *Fordham. Fordham University.* W. C. Repetti, S. J.

Lat., 40° 57′ 47″ N.; long., 73° 53′ 08″ W. Elevation, 23.9 meters.

Instrument: Wiechert 80 kg.

Instrumental constants.. {E V 72, T_0 7.2, ϵ 1.5; N V 73, T_0 7.2, ϵ 3.75

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			H. m. s.	Sec.	μ	μ	Km.	
Oct. 2	......	L_E	23 52 52					Combined with microseisms on both components.
		L_N	23 53 00					
		F_N	23 57 26					
		F_E	23 58 26					
3	......	L_N	2 01 21					
		L_E	2 01 26					
		M_N	2 01 56	12		4		
		M_E	2 04 26	12	4			
		F_E	2 10 26					
		F_N	2 11 26					
3	......	iP_E	6 55 26					
		eP_N	6 55 30					
		eS_N	7 00 39	20		9		Complex wave.
		iS_E	7 00 44	26	38			Complex wave.
		eL_N?	7 04 56					
		eL_E?	7 05 26					
		M_N	{7 06 36 7 08 26}	10		596		Pen swung to extreme limit during this interval.
		M_E	7 09 36	9	354			
		F_E	8 16 26					
		F_N	8 26 00					
11	......	iP_N	19 33 38	3				
		iS_E	19 37 34					
		S_N	19 37 38					
		eL_N?	19 40 38					
		eL_E?	19 40 38					
		M_N	19 45 53	10		5		No decided maximum on E-W.
		F_N	20 17 38					
		F_E	20 22 38					

Panama Canal Zone. *Balboa Heights.* Isthmian Canal Commission.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, ——.

Instruments: Two Bosch-Omori 100 kg.

Instrumental constants.. V 10, T_0 20

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			H. m. s.	Sec.	μ	μ	Km.	
Oct. 11	......	P_E	19 35 55				1,340	Direction?
		P_N	19 36 00					
		S_E	19 37 55					
		S_N	19 38 05					
		L	19 40 00					
		M_N	19 36 08			100		
		M_E	19 36 10		100			
		F_N	19 51 40					
		F_E	19 56 25					
21	......	P	2 25 12				240	Direction SW.
		L	2 25 40					
		M_E	2 25 44		100			
		M_N	2 25 45			150		
		F_E	2 28 34					
		F_N	2 29 55					

Porto Rico. *Vieques. Magnetic Observatory.* U. S. Coast and Geodetic Survey. H. M. Pease.

Lat. 18° 09′ N.; long., 65° 27′ W. Elevation, 19.8 meters.

Instruments: Two Bosch-Omori.

Instrumental constants.. {E V 10, T_0 21.4; N V 10, T_0 21.1

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			H. m. s.	Sec.	μ	μ	Km.	
Oct. 3	......	P_E	7 02 04	8				
		P_N	7 02 10	4				
		S_N	7 09 04	12				
		S_E	7 09 20	10				
		L	7 16 26	27				
		M_E	7 20 00	20	470			
		M_N	7 22 43	22		750		
		C	7 34 30	12				
		F	8 10 00					
11	......	P	19 34 03	6				This earthquake was felt on the island of Porto Rico.
		L	19 34 48					
		M	19 35 14	8	1,900	2,400		
		C	19 39 00	6				
		F_N	19 47 00					
		F_E	19 57 00					

Utah. *Salt Lake City. University of Utah.* F. J. Pack.

Lat., 40° 46′ N.; long., 111° 54′ W. Elevation, 1,330 meters.

Instruments: Bosch-Omori, —— registration.

Instrumental constants.. ——.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			H. m. s.	Sec.	μ	μ	Km.	
Oct. 2	......	P	23 39 00					
		S	23 40 30					
		L	23 41 30					
		F	23 51 00					
3	......	P	1 48 20					
		S	1 48 50					
		L	1 49 40					
		F	2 00 40					
3	......	L	6 53 20					Threw stylus off.

Vermont. *Northfield. U. S. Weather Bureau.* Wm. A. Shaw.

Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.

Instruments: Two Bosch-Omori, mechanical registration.

Instrumental constants: {E V 10, T_0 15; N V 10, T_0 16

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915			H. m. s.	Sec.	μ	μ	Km.	
Oct. 2	......	P						P not discernible.
		S	23 56 07					
3		F	0 20 00					
3	......	P						P not discernible.
		S?	2 04 17					
		M	2 08 00					
		F	2 25 00					
3	III_r	P	6 59 53				3,590	Severe earthquake in Nevada. Many large maxima. N-S stylus ran off sheet.
		S	7 05 16					
		L	7 10 15					
		M_N	7 11 00					
		M_E	7 13 10					
		F	8 30 00					
11	......	L_N	2 54 30					Phases very indistinct.
11	I_r	P	19 38 37				2,730	Earthquake felt in Porto Rico.
		S?	19 43 00					
		M_N	19 51 40					
		F	20 45 00					
22	......	e_N	5 07 45					Phases less distinct on E-W.
		M	5 10 50					
		F	5 20 00					
28	......	e	16 20 40					Phases not discernible.
		F	16 30 00					

Canada. *Ottawa. Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.

Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 8[illegible] meters.

Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoyer 80 kg. vertical seismograph.

Instrumental constants.. V 120, T_0 26

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915			H. m. s.	Sec.	μ	μ	Km.	
Oct. 2	......	P?	23 51 10					Somewhat masked by microseisms.
		$PR1_N$?	23 52 20					
		S_N	23 56 14					
		S_E	23 56 15					
		L_E	23 58 12	8				
3		F	0 20 00					
3	......	P_E?	1 56 40					Somewhat masked by microseisms.
		P_N	1 56 44					
		i_E	1 59 46					
		L	2 04 00	8				
		F	2 40 00					
3	......	P_E	6 59 34	2			3,330	
		P_N	6 59 35	2				
		S	7 04 40	10				
		eL_N	7 09 12	20				
		eL_E	7 09 18	20				
		M_N	7 11 36	20		33		
		M_E	7 12 42	20	13			
		L	7 35 00	16				
		L	7 45 00	10				
		L	8 00 00	11-13				
		L	8 24 00	12-13				
		F	9 15 00					
				VERTICAL.	(A_Z)			
		L	*7 10 00*	*18*				
		M	*7 11 06*	*14*	**3,500*			
		M	*7 13 18*	*8*	**3,700*			
		M	*7 13 54*	*8*	**3,500*			

TABLE 2.—*Instrumental reports, October, 1915*—Concluded.

Canada. *Ottawa.* *Dominion Astronomical Observatory*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 11	......	P_E	2 47 11				5,430	P not well marked. Small microseisms.
		P_N	2 47 12					
		S	2 54 17					
		L	3 00 30	16				
		L	3 02 00 3 05 00	20				
		F	3 20 00					
11	......	P	19 40 00				2,140	Seismograph drum clock out of repair. Readings from "deformation instrument" where time scale is only 17.7 mm. per hour.
		S	19 43 36					
		L	19 46 06					
		M	19 46 54					
		F	20 44 00					

* Trace amplitude.

Canada. *Toronto.* *Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm. swing of boom=0.59″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 2	......	L	23 57 42					
		M	23 58 24		*200			
3		F	0 02 00					
3	......	iP	1 59 42					Marked small earthquake.
		S	2 04 24					
		L	2 06 06					
		M	2 06 42		*300			
		F	2 17 30					
3	......	iP	6 59 36				3,164	Origin in Nevada.
		iS	7 04 30					
		L	7 07 12					
		L	7 09 18					
		M	7 10 30		*27.000			
		M	7 11 36		*16,000			
		M	7 12 18		*12,000			
		L	7 24 30					
		M	7 25 36		*5,500			
		L	7 36 42					
		L	7 39 12					
		L	7 54 00					
		L	7 59 06					
		L	8 06 12					
		L	8 34 48					
		L	9 48 18					
		L	9 53 18					
		F	10 40 42					
5	......	L	14 14 30					Suspicion of air currents.
		iL	14 50 24		*100			
		F	14 53 30					
10	......	P?	6 44 54					Gradual thickening.
		S or L	6 54 06					
		iL	6 59 54					
		M	7 03 00		*200			
		F	7 17 06					
10	......	L	10 20 00		*50			
		F	10 32 00					
11	......	S?	2 54 36					
		L	3 05 42					
		M	3 08 00		*200			
		F	3 18 00					
11	......	P?	19 40 06				2,165	Marked disturbance.
		iS	19 43 42					
		L	19 46 12					
		iL	19 50 00					
		eL	19 50 30					
		M	19 53 48		*2,000			
		F?	20 39 48					
12	......							Earthquake lost; clock stopped.

* Trace amplitude.

Canada. *Victoria, B. C.* *Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instruments: Wiechert, vertical. Milne horizontal pendulum, North. In the meridian

Instrumental constant.. T_0 18. Pillar deviation: 1 mm. swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Oct. 2	......	P	23 44 29				220	Origin in south-eastern Washington.
		L	23 44 53					
		M	23 45 29		*600			
		F	23 51 29					
3	......	P	1 52 31				220	
		L	1 52 55					
		M	1 53 49		*2,200			
		F	2 00 25					
3	......	P	6 54 55				1,300	Origin in Nevada.
		L	6 57 13					
		M	6 57 25		*17,000			
		M	7 00 48		*38,000			
		L	7 21 12					
		L	8 15 00					
		F	10 35 25					
					VERTICAL. (A_Z)			
		P	*6 55 25*					
		S	*6 57 10*					
		L	*6 58 30*					
		M	*6 59 40*		**1,000*			
		F	?					
5	......	P	14 08 54				1,740	Origin in California?
		S	14 11 54					
		M	14 14 36		*200			
		F	14 43 54					
10	......	P	6 32 46				1,430	
		S	6 35 16					
		L	6 35 16					
		M	6 40 04		*200			
		F	6 49 46					
10	......	P	10 32 19				440	
		L	10 33 07					
		M	10 34 19		*100			
		F	10 38 07					
11	......	L?	3 14 13					
		L	3 17 19					
		L	3 22 13					
		M	3 32 19		*50			
		F	3 19 13					
11	......	P	19 58 32					
		S	20 03 02					
		L	20 08 20					
		M						M cut off.
		F	20 39 02					
12	......	P	1 34 05				1,650	
		L	1 36 56					
		M	1 39 23		*600			
		F	1 44 18					
12	......	P	22 06 56					
		M	22 08 58		*100			
		F	22 11 55					
28	......	P	16 17 06					
		M	16 18 06		*100			
		F	16 20 06					
31	......	P	10 25 37					
		L	10 25 51					
		M	10 26 21		*100			
		F	10 28 50					

* Trace amplitude.

TABLE 3.—*Late seismological reports.* (*Instrumental.*)

Massachusetts. *Cambridge. Harvard University Seismographic Station.* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

Instrumental constants	V	T_0	ε:1
E	80	23	0
N	50	25	4:1

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
June 22		*O*	3 24 22				6,790	
		eP	3 34 40					
		S_E	3 42 58	6				
		L	3 43 42	10				L indistinct.
		F?	3 50 48					
23		*O*	4 00 21				4,110	*O* from eL–S deciphered in light of published data in this REVIEW, June, 1915, p. 289–294. Origin in southern California. Local observers give time 4ʰ 00ᵐ.
		eP_N?	4 06 28					
		S	4 13 45	6				
		eL	4 17 31 4 18 08	10				
		F	4 54 00					
23		*O*	4 58 34				3,850	Second shock in southern California. Reported 4ʰ 56ᵐ. Vd. loc. cit. E–W component gives different but more doubtful readings. Short pre-phases.
		eS?	5 11 20					
		eL	5 14 31					
		M_N	5 14 38					
		F	5 35 00					
27		*O*?	15 36 10				3,525?	
		L_E	15 51 16					
		F	16 22 00					
July 8		*O*	22 30 48					
		L_E	23 08 41	15				
		L_E	23 12 27	28				
		L_E	23 14 45	24				
		F	23 25 56					
22		*O*?	4 06 08				7,140?	Readings doubtful.
		eP_N	4 16 44					
		S_N	4 25 20					
		S_E	4 25 36					
		eL_E	4 30 02					
		L_N	4 32 52					
		F	4 46 00					
25		*O*?	20 47 26				7,400?	eP uncertain. L illegible on N–S.
		S?	21 06 56	7				
		L_E	21 18 12	28				
		F	21 49 00					
29		L_E	10 55 58	20				Origin in Pacific region. Not registered at Barcelona or Heidelberg.
		L_E	10 59 46	15				
		F	11 04 22					
31		*O*	1 31 26				8,200	Aleutians off Kamchatka, near λ 168° E., φ 53° N.
		P_E	1 42 58					
		PR_E	1 45 48					
		PR_E	1 47 20					
		PR_N	1 52 28					
		S_E	1 52 28					
		S	1 52 40					
		SR_E	1 58 26					
		eL_E	2 03 02	60				
		L_N	2 03 56					
		L_E	2 10 10	22				
		L_N	2 19 54	14				
		F_E	4 21 00					

Massachusetts. *Cambridge. Harvard University*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1915.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Aug. 3		*O*	13 04 27				14,960	
		e	13 26 19					
		e	13 31 39					
		e	14 10 42					
		L_E	14 16 04	22–15				
		LR1	15 06 10	20				
		F	15 47 00					
6		*O*	13 12 03				9,000	
		eP?	13 23 25					eP in microseisms.
		S	13 35 09					
		eL_N	13 53 18	20				
		L_E	14 01 53	24–22				
		F	14 55 00					
7		*O*	15 04 16				7,000?	
		e	15 31 09					
		L	15 39 27	20				
		L	15 46 16	16				
		F	16 07 00					
19								A few seismic waves at about 1ʰ.
Sept. 6		*O*	17 20 36				10,300?	
		e	17 53 39					
		L	18 16 55					
		L	18 22 15	15				
		F	19 22 00					
7		*O*	1 20 30				3,580	Destructive earthquake in Guatemala and Salvador. Stylus ran off the drum several times during the maxima.
		iP_E	1 27 19	2				
		P_N	1 27 21	2				
		PR	1 27 51 1 27 56 1 28 33 1 28 40					
		iS_N	1 32 41					
		iS_E	1 33 54					
		eL_E	1 34 23	26				
		M_E	1 35 54					
		eL_N	1 37 01					
		M_E	1 38 07 1 38 35					
		M_N	1 39 42					
		M_E	1 39 44 1 40 01					
		M_N	1 40 53 1 40 58					
		M_E	1 41 03 1 42 58					
		M_N	1 43 20					
		M_E	1 44 05 1 44 21					
		C_N	1 45 03					
		M_E	1 45 22 1 46 11 1 47 14					
		C_E	1 50 02					
		LR_N	2 35 03	12–14				
		F_N	2 59 56					

O=time at origin.

SEISMOLOGICAL DISPATCHES.[1]

Am. S. S. *Algiers*, Oct. 15, 1915.

Ship's time, 2 a. m.; N. 28° 29′; W. 92° 45′. Felt a terrific shock in this position which woke everybody on board. Lasted for a couple of minutes. (U. S. Hyd. Office.)

Panama, Oct. 22, 1915.

Slight earthquake at Aquadulce, 40 miles SW. of Panama. No damage of importance. Shock not felt in Canal Zone. (Assoc. Press.)

Asheville, N. C., Oct. 29, 1915.

Two distinct shocks were felt here at 12:35 a. m. The shocks came about two minutes apart and lasted a few seconds each. No damage reported. (Assoc. Press; Intern. news serv.).

[1] Reported by the organization indicated and collected by the seismological station at Georgetown University, Washington, D. C.

SECTION VI.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

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Bigelow, Frank H.
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Earthquake of February 10, 1914. Ottawa. 1915. 14 p. plate. map. 29½ cm. (Publications of the Dominion observatory, Ottawa, vol. 3, no. 1.)

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Observations météorologiques faites en 1913. Neuchâtel. 1915. [58] p. 20½ cm. (Annexe au Rapport du directeur de l'Observatoire pour l'année 1913.)

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Aspirations-Psychrometer-Tafeln. 2. erweiterte Auflage. Braunschweig. 1914. xiv, 123 p. 32 cm.

Reed, William Gardner.
Rainfall data of Berkeley, California [1887–1914]. Berkeley. [1915.] 69–81 p. 27 cm. (University of California publications in engineering, v. 1, no. 5.)

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Über Feuchtigkeitsmessung der Luft. Leipzig. 1915. 193–218 p. 23 cm. (S.-A. aus der Zeitschrift für Hygiene und Infektionskrankheiten, 80. Bd., 1915.)

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

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Schreiber, Paul. Das Sinus-Logarithmenpapier und seine Verwendung bei der harmonischen Analyse. p. 443–449.
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SECTION VII.—WEATHER AND DATA FOR THE MONTH.

THE WEATHER OF THE MONTH.

P. C. DAY, Climatologist and Chief of Division.

[Dated: Washington, Dec. 3, 1915.]

PRESSURE.

The distribution of the mean atmospheric pressure over the United States and Canada and the prevailing direction of the winds are graphically shown on Chart VII, while the average values for the month at the several stations, with the departures from the normal, are shown in Tables I and III.

The mean pressure for the month as a whole was above the normal over most of the country. The only sections showing negative departures were the upper Mississippi and lower Missouri Valleys, the upper Lake region, and the Canadian Provinces from the Great Lakes to the Rocky Mountains. However, the positive departures, as a rule, were small, the greatest values appearing in the southern Rocky Mountain region. The negative departures were likewise small, except that they were quite pronounced in the Canadian Northwest.

The month opened with abnormally low pressure throughout the southeast, due to the passage of the subtropical storm across that region. It was likewise low in the northwest from the Great Lakes to the Pacific. Elsewhere the pressure was near or slightly above the normal.

Rather extensive and well-defined low and high pressure areas followed each other across the country at somewhat frequent intervals during the first half of the month. During the latter part of the second decade the pressure was relatively high throughout most districts, except in the Canadian Provinces it was somewhat below normal.

During the third decade generally low pressure prevailed along the northern border and in the Canadian Provinces, while throughout the central portions of the country, from the Pacific to the Atlantic, it was relatively high. In the south generally the pressure was near or slightly above the normal. The month closed with relatively high pressure throughout the southeastern districts and in the Central Pacific States. Elsewhere it was near the normal, except from the Great Plains region eastward to the upper lakes, and in all Canadian Provinces relatively low pressure obtained.

The distribution of the highs and lows was generally favorable for southerly and southwesterly winds in New England and the northern portions of the Middle Atlantic States, the Lake region, and the great central valleys, northerly and northeasterly in the South Atlantic and Gulf States, northwesterly in the coastal portion of the Middle Atlantic States and the central Missouri Valley. Elsewhere variable winds prevailed.

TEMPERATURE.

Low pressure over the Southeast at the beginning of the month, due to the northeastward movement of the severe tropical storm that reached the Louisiana coast near the close of September, was causing warmer weather in most eastern districts, while an advancing low from the Canadian Northwest was causing southerly winds and warm weather for the season in the districts between the Rocky Mountains and the Great Lakes. In the far Southwest temperatures were moderately low for the season. During the following few days there were only slight changes in temperature, but by the 5th high pressure had advanced into the Plains region and much colder weather had overspread the districts between the Mississippi River and the Rocky Mountains, with frosts over the central and northern portions. By the morning of the 7th the cool area had moved to the Atlantic coast and decidedly cool weather for the period of the year prevailed in the central valleys, with more or less frost. At the same time another cool area was advancing into the Northwest, and by the morning of the 8th an extensive area of high pressure was central in the lower Missouri Valley and heavy to killing frosts were general in the central valleys. During the following few days this cold area likewise moved to the Atlantic coast and the first killing frosts of the season occurred in the northern portions of the Gulf States and generally to the northward and eastward. As a whole, for the first 10-day period of the month the temperatures averaged below the normal over all portions of the country, except locally in the far West.

With the passage eastward of the above-mentioned cold area warmer weather set in, and during the following 10 days there was a very general tendency to higher temperatures in all districts, and the second decade of the month, as a whole, was warm throughout the entire country, the period being especially warm over the Atlantic coast districts and in the Northwest, where the positive departures ranged from 8° to 11°.

During the last decade of the month, with the exception of short intervals, locally, the temperatures continued high for the season of the year, due to the rapid succession of low-pressure areas moving eastward along the northern border. As a result southerly winds were prevalent over large areas and the average temperatures for the decade equaled or exceeded the normal in all districts, the departures from the normal ranging from +6° to +14° over much of the central valleys and far western districts.

At the close of the month fair weather and seasonable fall temperatures continued in nearly all portions of the country.

MAXIMUM TEMPERATURES.

During the early portion of the month day temperatures were within a few degrees of the highest of record for October on several dates at points in the Plateau and Pacific Coast States, and on the 6th locally in the Florida Peninsula. Otherwise the maximum temperatures were well within the limits of other years and were generally less than 90°, except at points in the Southeastern States, in central and southern Texas, and at the lower elevations of Arizona and the interior of California. The highest recorded, 104°, occurred in southwestern Arizona.

MINIMUM TEMPERATURE.

Freezing temperatures were reported during the cold wave, near the end of the first decade, from northern New Mexico northeastward to the Lake region and generally over the Appalachian Mountain region and New England, but during the remainder of the month the night tempera-

tures were generally high for the season of the year, and at the end killing frost had not yet occurred over much of the southern portions of the country. Minimum temperatures of 20° or lower were reported during the early part of the month at points in North Dakota and locally in the northern Rocky Mountain and Plateau regions. Over the Pacific Coast States no freezing temperatures were reported at the lower elevations.

MONTHLY AVERAGES.

Although the monthly means were not as a rule unusually high, the fact that throughout the entire country, save in one or two instances along the immediate Pacific coast, they were everywhere above the normal, is a most unusual condition. Only in rare instances are the temperature conditions for a whole month over the entire country uniformly above or below the normal for the season.

PRECIPITATION.

During the closing days of September a destructive tropical storm passed inland from the Gulf of Mexico, near the mouth of the Mississippi River, and moved thence rapidly northeastward, but with decreasing intensity, during the first few days of October. The storm was accompanied by general and in some cases heavy rains over the districts to the eastward of the Mississippi River.

At the time the tropical storm was passing over eastern districts, unsettled barometric conditions obtained in the Northwest, and on the morning of the 3d a well-defined low area appeared in the central Plains region, which, moving thence northeastward over the Lakes during the following few days, resulted in another period of generally showery weather to the eastward of the Mississippi River.

On the 6th–8th a depression of pronounced formation moved eastward over the northern border States, but without extensive precipitation, and by the 9th the weather had become generally clear under the influence of an extensive area of high pressure that had covered nearly all districts to the eastward of the Rockies. Generally fair weather continued until about the 12th or 13th, when local showers set in throughout the Mississippi Valley, extending eastward to the Atlantic coast districts during the following day or two, and during the last half of the second decade unsettled, showery weather was the rule over much of the country to the eastward of the Rockies, but to the westward fair weather continued.

The last decade of the month was characterized by a remarkable absence of precipitation throughout the country. Despite the fact that a number of well-defined areas of low pressure moved eastward over the northern border States in rapid succession during the decade, practically no rain occurred, except a few local showers in limited areas, and the month closed with clear, pleasant weather prevailing throughout practically the entire country.

The total precipitation for October, 1915, is shown on Chart V. For the month, as a whole, the rainfall was generally heavy in Alabama and Georgia and over the southern portion of the Appalachian Mountains, the greatest amounts appearing in the latter region, where at some points 12 inches or more of rain occurred. These amounts were largely due to the storms at the beginning of the month, referred to elsewhere. The monthly totals were also comparatively large in the upper portion of the Ohio drainage, and they were above the normal in parts of the Plains region, while heavy rains fell on the extreme north Pacific coast. However, with these exceptions the monthly precipitation was quite generally below the normal, the minus departures being especially marked in the central Mississippi Valley, over much of the Lake region and northeastern States, and generally to the westward of the Rocky Mountains. Except locally in the far Northwest, but little precipitation occurred during the month in the districts to westward of the Rocky Mountains, nearly the whole of the central and southern portions being practically rainless.

GENERAL SUMMARY.

Except for the severe cold during the early part of the month over the northern and central districts, causing much damage in western portions of the corn belt, the month as a whole was favorable for all occupations usual to the season.

In the principal agricultural districts the weather was generally favorable for the gathering of corn, cotton, and other crops, and for the seeding and germination of fall sown grain.

Pastures east of the Rocky Mountains generally continued green throughout the month, affording ample food for stock, which was reported in fine condition to enter the winter. To the westward of the mountains dry weather had so injured the pastures that in some districts feeding was necessary.

In the truck growing districts of the South the weather was generally favorable for most crops.

Average accumulated departures for October, 1915.

Districts.	Temperature. General mean for the current month.	Temperature. Departure for the current month.	Temperature. Accumulated departure since Jan. 1.	Precipitation. General mean for the current month.	Precipitation. Departure for the current month.	Precipitation. Accumulated departure since Jan. 1.	Cloudiness. General mean for the current month.	Cloudiness. Departure from the normal.	Relative humidity. General mean for the current month.	Relative humidity. Departure from the normal.
	°F.	°F.	°F.	Ins.	Ins.	Ins.	0–10		P. ct.	
New England	52.5	+2.1	+11.6	2 72	−0.90	−4.10	5.7	+0.3	81	+ 2
Middle Atlantic	57.8	+2.2	+ 9.5	2.69	−0.60	−1.50	5.0	+0.2	77	+ 1
South Atlantic	67.4	+3.8	+ 4.2	3.42	−0.20	−6.00	4.4	+0.4	81	+ 3
Florida Peninsula	78.9	+2.5	− 5.7	5.80	−0.50	−4.20	5.2	+0.5	80	0
East Gulf	68.7	+3.1	+ 4.1	6.16	+3.40	+0.20	4.1	+0.2	79	+ 6
West Gulf	68.8	+2.2	− 3.0	2.76	0.00	−3.30	2.3	−1.4	71	− 1
Ohio Valley and Tennessee	59.6	+2.8	− 2.6	2.19	−0.40	−1.80	4.0	−0.4	74	+ 3
Lower Lakes	53.4	+1.6	− 1.5	2.53	−0.50	−0.40	5.7	−0.2	76	+ 2
Upper Lakes	49.9	+2.1	+ 5.9	1.52	−1.30	−1.70	5.9	−0.1	78	0
North Dakota	47.6	+5.0	+13.1	1.13	−0.20	−0.80	4.3	−0.9	71	− 1
Upper Mississippi Valley	55.9	+3.1	+ 0.2	1.12	−1.30	+5.60	4.2	−0.4	70	− 1
Missouri Valley	57.1	+4.4	− 3.6	1.24	−0.70	+7.80	3.4	−0.7	66	− 1
Northern slope	49.5	+4.8	+ 2.7	0.69	−0.20	+2.60	4.6	+0.2	60	0
Middle slope	58.0	+2.5	− 9.7	1.73	+0.20	+8.00	2.5	−0.9	60	+ 1
Southern slope	63.7	+1.2	−10.2	0.75	−1.20	+2.20	2.2	−2.4	63	0
Southern Plateau	61.8	+1.9	−15.3	0.04	−0.50	+1.00	0.8	−1.4	39	− 3
Middle Plateau	53.2	+2.5	− 0.4	0.02	−0.80	−1.20	1.6	−1.7	36	−13
Northern Plateau	53.0	+3.6	+16.4	0.47	−0.80	−0.60	5.0	+0.4	49	−14
North Pacific	53.0	+1.9	+22.2	4.49	+0.50	−7.20	7.1	+0.8	80	0
Middle Pacific	60.6	+1.8	+ 8.4	0.22	−1.40	+2.80	2.6	−1.8	58	−12
South Pacific	64.0	+1.7	+12.5	0.00	−0.80	+2.90	1.9	−1.2	69	− 1

Maximum wind velocities, October, 1915.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		Mis./hr.				Mis./hr.	
Block Island, R. I.	2	54	ne.	North Head, Wash	31	71	se.
Do	30	59	nw.	Pierre, S. Dak	24	51	w.
Buffalo, N. Y	8	52	w.	Point Reyes Light, Cal	9	50	nw.
Cheyenne, Wyo	31	58	w.	Do	10	60	nw.
Duluth, Minn	7	53	w.	Do	13	54	nw.
Do	8	52	nw.	Do	30	58	nw.
Mount Tamalpais, Cal	1	60	n.	Do	31	56	nw.
Do	2	58	n.	Providence, R. I.	30	52	nw.
Do	9	60	nw.	Sand Key, Fla	25	50	se.
Do	23	56	nw.	Seattle, Wash	21	58	sw.
Do	30	54	nw.	Do	31	51	s.
Nantucket, Mass	2	60	ne.	Sheridan, Wyo	24	54	nw.
New York, N. Y	23	60	nw.	Tatoosh Island, Wash	20	50	s.
Do	30	65	nw.	Do	21	58	s.
North Head, Wash	13	54	se.	Do	26	68	s.
Do	21	66	s.	Do	27	71	s.
Do	24	68	se.	Do	31	61	sw.
Do	26	60	s.				

WEATHER CONDITIONS ON THE NORTH ATLANTIC DURING OCTOBER, 1914.

The data presented are for October, 1914, and comparison and study of the same should be in connection with those appearing in the REVIEW for that month. Chart IX (XLIII—122) shows for October, 1914, the averages of pressure, temperature, and the prevailing direction of the winds, together with the locations and courses of the more severe storms of the month.

For the month as a whole the distribution of the atmospheric pressure over the greater part of the ocean was not unlike the normal shown on the Meteorological Chart of the North Atlantic Ocean for October. The Azores high was of less prominence than usual, though a trace of it appears near its usual position, where in two 5° squares the average barometric pressure for the month was 30.10 inches.

A second high of about the same intensity was central over the eastern portion of the United States, extending out over the ocean as far as the sixty-ninth meridian. The isobar indicating the lowest average barometer readings shown on the chart, 29.80 inches, was of normal intensity and near its usual position, some distance south of the apparent center of the Icelandic low, the exact location of which it was impossible to plot on account of lack of reports from that part of the ocean. This unusual uniformity of pressure, with the small gradients that prevailed over the greater part of the ocean, was responsible for the large number of days with light and variable winds, there being few gales reported during the first two decades of the month.

On the 19th a low (I on Chart IX) appeared near latitude 55° N., longitude 32° W. There were few vessels in the immediate vicinity of this apparent center, and none of them reported very heavy winds, although the Danish steamer *Texas*, at latitude 51°, longitude 42°, recorded a gale of 65 miles an hour. From its position on the 19th the storm moved in a southeasterly direction, and on the 20th was centered near latitude 50°, longitude 20°, the barometer reading 29.50 inches, and several vessels reporting winds of 48 miles an hour, while 5° north of the center the British steamship *Rathlin Head* encountered a 65-mile gale.

By the 21st the low had moved due east to longitude 13°, the wind having decreased near the center, though the *Rathlin Head*, which had sailed in an easterly direction at about the same rate of speed as the storm, reported a northerly gale of 65 miles an hour near latitude 45°, longitude 15°. On the 22d the low was near latitude 52°, longitude 7°, the wind having decreased in force to 48 miles an hour in the southwest quadrant, while near the center it ranged from 30 to 36 miles.

On October 22 a second low (II on Chart IX) was centered about 200 miles north of St. Johns, N. F., accompanied by comparatively light winds. This moved in an easterly direction and on the 23d the center was located near latitude 48°, longitude 38°. The lowest barometer reading was 28.81 inches, and one vessel reported a southwesterly wind of 75 miles an hour, the highest velocity recorded during the month. From this point the movement of the storm was slow, as on the 24th the center was about latitude 49°, longitude 33°, the barometer having risen to 29.92 inches, and the velocity of the wind decreased slightly, although a vessel 12° west of the center reported a northwest gale of 65 miles an hour. The storm then moved toward the north and on the 26th was centered near latitude 55°, longitude 32°, with a slightly lower barometer reading than on the previous day and about the same wind velocity. This disturbance evidently continued on its northerly course, although it is impossible to plot its track on account of lack of observations. The area covered by winds of gale force on the 28th was quite large as one vessel near latitude 55°, longitude 32°, reported a barometer reading of 29.33 inches, with a northwest wind of 65 miles, while at latitude 48°, longitude 25°, with a barometer reading of 30.16 inches, there was a westerly wind of 56 miles, the velocities reported by vessels between these two points ranging from 40 to 48 miles an hour.

On the 25th a slight disturbance (III on Chart IX) appeared near latitude 17°, longitude 86°, accompanied by light winds near its center, although a ship between New Orleans and Galveston reported a northeast gale of 48 miles an hour. This storm moved slowly in a northeasterly direction, but by the 27th it had increased in velocity, and was centered near latitude 44°, longitude 66°, but without heavy winds near its center, although two ships reported northerly gales of 48 miles off Hatteras. On the 28th it was near the southern coast of Newfoundland, having increased in intensity, as several vessels encountered winds of from 48 to 56 miles an hour. It then moved in an easterly direction, and on the 29th was near latitude 46°, longitude 36°, the winds having decreased in velocity and the barometer risen, showing that the low was gradually filling in.

TEMPERATURES.

The temperatures of the air over the ocean as a whole were irregular, the departures from the normal ranging from +7° F. off the coasts of Spain and France to −6° in the 5° square bounded by parallels 50° and 55°, and meridians 35° and 40°. At a number of Weather Bureau stations on the Atlantic coast the departures were as follows: Eastport, +2.6°F.; Boston, +4.7°; New York, +3.4°; Norfolk, +2.6°; Hatteras, +1°; Wilmington, +2.5; Charleston, +1.3°; Jacksonville, +1.9°; Miami, −1.8°; Key West, −0.4;° Tampa, +1.6°; Pensacola, −0.6°; New Orleans, +0.8°; Galveston, −0.7°; and Corpus Christi, +0.2°.

The greatest monthly range of temperature for any one 5° square was from 49° to 71°, which occurred in the square between latitude 35° and 40° and longitude 75° and 80°, while in mid-ocean along the trans-Atlantic routes the range seldom exceeded 18°, which is somewhat larger than the maximum observed in September for the same region.

FOG.

Observations of fog during October for the six-year period from 1901 to 1906, as shown on the Meteorological Chart of the North Atlantic for October, indicate that the greatest number of days on which fog was observed occurred in an area centered near latitude 46°, longitude 49°. Here the normal percentage was given as from 30 to 35, while for October, 1914, fog was observed in that vicinity on three days only, or a percentage of 10. Near latitude 43°, longitude 22°, the normal percentage is from 20 to 25, while for the month under discussion it was zero. The number of days with fog was less than the normal on all parts of the ocean, and along the trans-Atlantic routes this difference was marked, as no reports of fog were received for the month east of the forty-fifth meridian.

The first snow of the season was reported on October 17 by two vessels near latitude 53°, longitude 42°, and again on the 18th and 20th, while hail was recorded on the 17th near latitude 50°, longitude 46°.

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data, as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, October, 1915.

Section.	Temperature.								Precipitation.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		Ins.	Ins.		Ins.		Ins.
Alabama	67.1	+3.1	Evergreen	94	3†	Hamilton	28	10	4.93	+2.48	Dadeville	8.68	Pushmataha	0.99
Arizona	63.8	+1.8	2 stations	107	7†	Fort Valley	18	12	0.13	−0.71	Oracle	1.23	26 stations	0.00
Arkansas	63.4	+1.5	Camden	94	16	Dutton	26	9	2.83	+0.05	Mena	6.79	Whitecliffs	0.10
California	62.3	+1.2	Riverside	105	28	Macdoel	8	25	0.14	−1.31	Branscomb	2.42	184 stations	0.00
Colorado	48.4	+1.9	Wray	91	8	2 stations	8	5†	0.63	−0.50	Waterdale	3.02	9 stations	0.00
Florida	75.4	+3.0	Brooksville (1)	96	4†	2 stations	40	10	7.51	+3.56	Orlando	19.10	Tampa	1.37
Georgia	67.6	+3.4	6 stations	94	3	3 stations	30	10	6.72	+4.03	Toccoa	13.33	Waycross	2.39
Hawaii (September)	75.1	......	Mahukona, Hawaii	95	7	Volcano House, Hawaii.	52	18†	6.23	......	Waiakamoi, Maui	23.79	Makapuu, Oahu	0.07
Idaho	49.1	+2.7	Mountainhome	91	8	Roseberry	6	24	0.62	−0.80	Burke	3.44	10 stations	0.00
Illinois	56.7	+2.0	2 stations	86	3	3 stations	20	9	0.83	−1.70	New Burnside	2.43	Roberts	0.23
Indiana	56.7	+2.0	2 stations	88	22†	5 stations	24	10	1.43	−1.22	Whitestown	2.75	Hammond	0.24
Iowa	54.4	+3.6	Belle Plaine	86	3	2 stations	19	9	1.31	−1.15	Whitten	3.25	Leon	T.
Kansas	50.0	+2.2	2 stations	94	10	Blakeman	19	8	1.55	−0 47	St. Francis	3.68	3 stations	0.00
Kentucky	60.6	+2.9	Beattyville	90	15	4 stations	27	10†	3.40	+1.12	Berea	7.80	Lexington	0.81
Louisiana	70.2	+2.7	Angola	100	17	Kelly	31	10	4.91	+2.01	Paradis	16.15	Logansport	0.32
Maryland and Delaware.	57.9	+1.5	Western Port, Md	88	15	Oakland, Md	19	24	3.88	+0.82	Salisbury, Md	6.06	Green Spring Furnace, Md.	1.85
Michigan	49.9	+1.4	2 stations	80	3	Seney	15	24	1.68	−1.00	Watersmeet	4.19	Charlotte	0.33
Minnesota	48.5	+2.6	Montevideo	82	2	Itasca State Park	13	9	2.04	−0.22	Pine River Dam	5.34	Halstad	0.22
Mississippi	67.0	+2.8	3 stations	93	16†	Columbia	29	10	3.40	+1.14	Holly Bluff	8.52	Utica	0.57
Missouri	59.8	+2.6	Cardwell	95	28	Bethany	22	9	1.19	−1.45	Hollister	3.05	Liberty	0.10
Montana	47.7	+4.3	Busteed	91	23	Bowen	3	8	0.65	−0.52	Heron	3.18	2 stations	0.00
Nebraska	54.8	+3.8	Loup City	97	24	Gordon	14	8	1.27	−0.32	Stratton	3.76	Hastings	0.22
Nevada	53.3	+3.4	Logan	99	8	Potts	13	12	0.01	−0.53	Duck Flat	0.19	40 stations	0.00
New England	51.3	+2.2	Plymouth, Mass	82	15	Chelsea, Vt	18	25	2.77	−0.79	Block Island, R. I.	5.18	St. Johnsbury, Vt	1.48
New Jersey	56.2	+2.1	Elizabeth	84	15	Charlotteburg	23	25	3.03	−0.70	Tuckerton	5.18	Lambertville	1.89
New Mexico	54.0	+0.8	Artesia	92	3	Virsylvia	9	27	0.34	−0.81	Hollene	1.64	17 stations	0.00
New York	51.1	+1.2	Canisius College	82	4	Wanakena	11	25	3.16	−0.27	New Berlin	5.36	Fishs Eddy	0.94
North Carolina	62.6	+3.2	Greenville	92	1	Highlands	22	10	4.03	+0.75	Highlands	12.30	Kinston	1.19
North Dakota	46.5	+2.7	Jamestown	85	22	Fessenden	12	8	1.03	−0.01	Ashley	3.62	2 stations	T.
Ohio	55.4	+2.1	Waverly	89	13	Millport	20	24	2.39	−0.16	Syracuse	5.51	Somerset	0.86
Oklahoma	62.5	+0.8	Eufaula	93	1	Kenton	26	7†	3.69	+1.13	Ravea	10.70	Kenton	0.36
Oregon	52.3	+1.3	McKinley	88	8	Cliff	6	11	1.36	−0.74	Glenora	11.69	Drewsey (2)	0.00
Pennsylvania	54.2	+1.9	Johnstown	85	4	West Bingham	17	25	2.65	−0.49	Mount Pocono	5.33	Waterville	1.00
Porto Rico	79.2	+1.0	2 stations	99	27†	Maricao	55	2†	6.80	−1.90	Rio Grande (El Verde).	26.92	Caguas	1.20
South Carolina	67.0	+3.8	2 stations	93	3†	Mountain Rest	27	10	4.93	+1.75	Mountain Rest	9.38	Centenary	2.54
South Dakota	52.0	+3.3	2 stations	89	23†	2 stations	14	7†	1.52	+0.13	Britton	4.23	Elk Mountain	0.26
Tennessee	61.9	+2.9	2 stations	90	3†	Rugby	22	10	3.42	+0.93	Decatur	8.77	Nashville	0.42
Texas	68.1	+0.9	Mission	102	3	2 stations	29	25†	1.54	−1.15	Denison	5.68	12 stations	0.00
Utah	50.2	+1.6	St. George	93	31	Scofield	10	13	0.19	−0.83	Trout Creek	2.90	32 stations	0.00
Virginia	59.3	+2.9	Ivor	86	1	Burkes Garden	19	31	3.75	+0.58	Quantico	7.09	Burkes Garden	0.74
Washington	51.5	+1.8	Mottinger	85	1	Deer Park	16	6	3.35	+0.78	Queets River	16.84	Eltopia	T.
West Virginia	56.6	+1.9	Creston	89	14	2 stations	20	10†	4.11	+1.06	Spencer	5.55	Nuttallburg	0.74
Wisconsin	49.2	+1.5	Beloit (3)	78	3†	Hayward	12	9	1.90	−0.99	Vudesare	5.10	Dodgeville	0.34
Wyoming	45.3	+3.1	2 stations	85	9†	2 stations	7	8†	0.69	−0.35	Lagrange	3.01	8 stations	0.00

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS.

Table I gives the data ordinarily needed for climatological studies for about 158 Weather Bureau stations, making simultaneous observations at 8 a. m. and 8 p. m., daily, seventy-fifth meridian time, and for about 41 others making only one observation. The altitudes of the instruments above ground are also given.

Table II gives a record of precipitation, the intensity of which at some period of the storm's continuance equaled or exceeded the following rates:

Duration (minutes)	5	10	15	20	25	30	35	40	45	50	60
Rates per hour (inches)	3.00	1.80	1.40	1.20	1.08	1.00	0.94	0.90	0.87	0.84	0.80

It is impracticable to make this table sufficiently wide to accommodate on one line the record of accumulated falls that continue at an excessive rate for several hours. In this case *the record is broken at the end of each 50 minutes*, the accumulated amounts being recorded on successive lines until the excessive rate ends.

In cases where no storm of sufficient intensity to entitle it to a place in the full table has occurred, the greatest precipitation of any single storm has been given, also the greatest hourly fall during that storm.

The tipping-bucket mechanism is *dismounted* and removed when there is danger of snow or water freezing in the same. Table II records this condition by entering an asterisk (*).

Table III gives, for about 30 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation and depth of snowfall, and the respective departures from normal values except in the case of snowfall.

Chart I.—Hydrographs for several of the principal rivers of the United States.

Chart II.—Tracks of centers of high area; and

Chart III.—Tracks of centers of low areas. The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the observations at 8 a. m. and 8 p. m., 75th meridian time. Within each circle is also given (Chart II) the last three figures of the highest barometric reading and (Chart III) the lowest reading reported at or near the center at that time, and in both cases as reduced to sea level and standard gravity.

Chart IV.—Temperature departures. This chart presents the departures of the monthly mean temperatures from the monthly normals. The normals used in computing the departures were computed for a period of 33 years (1873 to 1905) and are published in Weather Bureau Bulletin "R," Washington, 1908. Stations whose records were too short to justify the preparation of normals in 1908 have been provided with normals as adequate records became available, and all have been reduced to the 33-year interval 1873-1905. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July, 1909.

Chart V.—Total precipitation. The scale of shades showing the depth is given on the chart. Where the monthly amounts are too small to justify shading, and over sections of the country where stations are too widely separated or the topography is too diversified to warrant reasonable accuracy in shading, the actual depths are given for a limited number of representative stations. Amounts less than 0.005 inch are indicated by the letter T, and no precipitation by 0.

Chart VI.—Percentage of clear sky between sunrise and sunset. The average cloudiness at each Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the nighttime.

Chart VII.—Isobars and isotherms at sea level and prevailing wind directions. The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow on pages 13-16 of the REVIEW for January, 1902. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of the 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observation, respectively, at stations taking but a single observation. The diurnal corrections so applied will be found in the Annual Report of the Chief of the Weather Bureau, 1900-1901, volume 2, Table 27, pages 140-164.

The isotherms on the sea-level plane have been constructed by means of the data summarized in chapter 8 of volume 2 of the annual report just mentioned. The correction t_0-t, or temperature on the sea-level plane minus the station temperature as given by Table 48 of that report, is added to the observed surface temperature to obtain the adopted sea-level temperature.

The prevailing wind directions are determined from hourly observations at the great majority of the stations; a few stations having no self-recording wind-direction apparatus determine the prevailing direction from the daily or twice-daily observations only.

Chart VIII.—Total snowfall. This is based on the reports from regular and cooperative observers and shows the depth in inches and tenths of the snowfall during the month. In general, the depth is shown by lines inclosing areas of equal snowfall, but in special cases figures are also given. Chart VIII is published only when the general snow cover is sufficiently extensive to justify its preparation.

Chart IX.—Average values of pressure and temperature, the prevailing wind directions, and storm tracks over the North Atlantic Ocean, for the corresponding month of last year.

TABLE I.—*Climatological data for United States Weather Bureau Stations, October, 1915.*

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.												Precipitation.			Wind.										
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles.								0-10		
New England.							52.5	+2.1										81	2.72	−0.9										5.7		
Eastport	76	67	85	29.96	30.04	+0.04	48.6	+2.0	67	17	54	32	23	43	23	45	42	79	1.86	−2.0	9	7,531	s.	32	nw.	31	10	10	11	5.6		
Greenville	1,070	6																														
Portland, Me.	103	82	117	29.96	30.08	+.04	51.2	+2.1	73	12	59	33	11	44	31	46	42	74	1.49	−2.2	10	6,417	s.	33	nw.	23	15	2	14	5.4		
Concord	288	70	79	29.78	30.09	+.04	50.3	+1.6	76	21	61	24	25	40	39				3.02	−0.2	9	3,569	nw	24	nw.	30	13	4	14	5.4	T.	
Burlington	404	11	48	29.63	30.07	+.03	50.3	+3.4	71	13	58	27	25	42	30				2.74	−0.4	11	9,537	s.	43	s.	5	5	10	16	6.8	T.	
Northfield	876	12	60	29.13	30.09	+.05	47.3	+3.7	74	13	58	20	25	37	37	43	40	83	1.72	−0.8	12	5,412	s.	30	nw.	23	6	10	15	6.9	T.	
Boston	125	115	188	29.94	30.08	+.03	55.7	+3.4	78	13	63	37	25	48	26	50	47	77	2.82	−1.0	9	7,276	sw.	32	ne.	2	12	6	13	5.2		
Nantucket	12	14	90	30.07	30.08	+.03	54.8	+0.3	72	14	60	40	24	49	22	51	49	84	3.18	−0.2	13	10,996	sw.	60	ne.	2	9	9	13	6.1		
Block Island	26	11	46	30.06	30.09	+.04	55.2	−0.1	70	14	60	39	25	51	14	53	50	85	5.18	+1.1	11	12,829	nw.	59	nw.	30	14	3	14	5.4		
Narragansett Pier		9					53.4	+1.3	75	15	61	29	24	45	27				4.65		10		s.				19	2	10			
Providence	160	215	251	29.90	30.08	+.03	53.8	+1.6	75	14	62	34	24	46	26	49	45	78	1.86	−2.0	13	8,744	nw.	52	nw.	30	13	9	9	4.8		
Hartford	159	122	140	29.92	30.09	+.03	54.4	+3.2	76	21	63	31	25	46	29	50	47	82	2.74	−1.1	10	5,337	s.	37	nw.	30	12	6	13	5.6	T.	
New Haven	106	117	155	29.98	30.09	+.03	55.4	+2.6	76	15	63	33	25	48	26	51	48	83	3.30	−0.6	11	6,572	s.	31	s.	5	13	6	12	5.1		
Middle Atlantic States.							57.8	+2.2										77	2.69	−0.6										5.0		
Albany	97	102	115	29.98	30.09	+.03	53.3	+2.9	73	21	61	30	25	46	29	48	44	77	2.15	−0.8	10	5,675	s.	31	se.	26	9	12	10	5.5		
Binghamton	871	10	69	29.16	30.10	+.04	52.0	+2.8	76	4	61	27	25	43	37				2.56	−0.6	13	3,515	nw.	28	nw.	30	9	6	16	6.0	T.	
New York	314	414	454	29.76	30.10	+.04	56.7	+1.1	77	15	64	37	25	50	20	51	46	73	2.25	−1.5	11	11,447	nw.	65	nw.	30	12	7	12	5.5		
Harrisburg	374	94	104	29.73	30.13	+.05	56.5	+2.5	78	15	64	33	25	48	27	50	46	74	1.92	−1.0	9	4,306	nw.	27	nw.	30	15	4	12	5.0		
Philadelphia	117	123	190	30.00	30.12	+.05	59.4	+3.1	79	21	66	40	25	52	25	53	50	77	1.98	−1.1	9	6,954	nw.	36	nw.	30	14	9	8	4.4		
Reading	325	81	98	29.78	30.13		56.8		79	15	65	34	25	48	30	51	46	76	3.18	−0.1	9	4,475	nw.	31	nw.	30	11	9	11	5.4		
Scranton	805	111	119	29.25	30.12	+.05	53.4	+2.0	76	21	62	29	11	45	36	48	45	78	1.13	−1.8	9	4,383	sw.	27	w.	30	3	15	13	6.8		
Atlantic City	52	37	48	30.06	30.12	+.05	58.0	+0.6	73	27	64	35	24	52	25	54	51	79	4.17	+0.9	11	5,430	nw.	31	e.	1	14	6	11	5.0		
Cape May	18	13	49	30.12	30.14	+.07	59.4	−0.2	76	15	66	36	25	53	23				3.64	+0.3	8	6,278	nw.	36	ne.	1	15	7	9	4.4		
Sandy Hook	22	10	57	30.08	30.10		57.8		77	15	63	41	24	52	20	53	50	80	3.33		11	10,823	nw.	49	nw.	30	14	10	7	4.6		
Trenton	190	159	183	29.90	30.10		56.6		79	15	65	35	25	48	28	51	47	78	1.99	−1.4	9	7,257	nw.	39	nw.	30	12	10	9	5.2		
Baltimore	123	100	113	30.00	30.13	+.05	59.6	+2.1	80	21	67	38	24	52	26	54	49	75	3.86	+0.8	8	4,500	s.	28	ne.	1	16	4	11	4.6		
Washington	112	62	85	30.00	30.12	+.04	58.6	+2.0	81	4	68	34	25	50	30	53	49	78	3.72	+0.6	13	3,918	nw.	29	nw.	30	17	3	11	4.5		
Lynchburg	681	153	188	29.38	30.12	+.03	60.6	+3.7	84	15	71	32	11	50	38	53	50	78	3.21	−0.2	9	3,579	nw.	25	nw.	8	15	7	9	4.7		
Norfolk	91	170	205	30.03	30.13	+.06	64.4	+3.1	82	1	71	44	10	58	24	58	54	76	2.29	−1.6	6	8,173	n.	36	w.	1	14	7	10	4.5		
Richmond	144	11	52	29.97	30.13	+.05	61.3	+1.5	83	4	71	35	25	51	33	55	52	83	3.27	0.0	7	4,528	se.	33	se.	1	13	9	9	4.8		
Wytheville	2,293	40	47	27.76	30.14	+.05	56.6	+3.0	81	15	68	29	11	45	40	50	46	80	1.79	−1.4	10	2,627	nw.	17	w.	8	14	8	9	4.5		
South Atlantic States.							67.4	+3.8										81	3.42	−0.2										4.4		
Asheville	2,255	70	84	27.80	30.15	+.06	58.4	+3.1	80	16	68	27	10	48	36	52	49	81	3.33	+0.4	12	4,860	nw.	27	se.	1	14	6	11	4.7		
Charlotte	773	153	161	29.28	30.12	+.04	64.4	+3.3	83	15	73	37	10	56	28	57	53	74	2.97	−0.2	10	6,377	ne.	35	sw.	1	14	5	12	4.7		
Hatteras	11	12	50	30.09	30.10	+.04	68.4	+2.4	83	1	73	50	25	63	17	63	61	81	3.40	−2.6	10	8,836	ne.	34	n.	9	12	12	7	4.5		
Manteo	12	4	46				65.3		84	1	73	37	25	57					3.44	−2.6	5		ne.				18	5	8			
Raleigh	376	103	110	29.72	30.12	+.05	64.2	+3.7	85	1	73	37	10	55	27	57	53	75	2.59	−0.9	9	4,368	ne.	22	sw.	1	14	6	11	4.3		
Wilmington	78	81	91	30.03	30.11	+.05	67.4	+4.1	84	1	76	40	10	59	27	61	58	81	1.53	−2.2	8	4,921	ne.	26	sw.	1	16	7	8	3.8		
Charleston	48	11	92	30.04	30.08	+.02	70.8	+3.7	86	1	77	46	10	64	20	65	62	80	4.27	+0.3	10	7,542	n.	30	sw.	1	13	13	5	4.1		
Columbia, S. C.	351	41	57	29.73	30.11	+.04	68.1	+4.1	86	3	77	41	10	59	28	60	56	76	3.88	+1.0	10	4,092	ne.	24	sw.	1	17	4	10	4.2		
Augusta	180	89	97	29.91	30.10	+.03	68.4	+4.8	87	16	78	42	10	59	27	62	60	83	6.42	+4.1	10	3,451	ne.	20	sw.	1	14	7	10	4.4		
Savannah	65	150	194	30.01	30.08	+.03	71.0	+4.7	89	5	78	43	10	63	24	65	63	83	3.32	−0.2	7	7,925	ne.	40	w.	5	13	10	8	4.7		
Jacksonville	43	209	245	29.99	30.04	+.02	73.4	+3.8	90	5	79	52	10	68	21	68	66	86	5.45	+0.4	15	9,268	ne.	37	nw.	5	13	10	8	5.0		
Florida Peninsula.							78.9	+2.5										80	5.80	−0.5										5.2		
Key West	22	10	64	29.91	29.93	−.01	80.9	+2.2	90	8	86	72	26	76	13	74	72	78	4.27	−1.1	11	7,449	ne.	28	e.	25	13	12	6	4.7		
Miami	25	71	79	29.93	29.96	+.02	78.9	+1.1	88	2	83	68	27	75	13	74	72	81	11.65	+1.1	22	8,648	e.	38	ne.	27	5	17	9	6.0		
Sand Key	23	39	72	29.88	29.92	−.02	79.4		87	2	82	69	29	77	11	75	73	80	6.39		10	11,403	e.	50	se.	25	13	13	5	4.5		
Tampa	35	79	96	29.96	30.00	+.02	76.8	+4.2	91	6	84	55	10	69	25	69	67	79	1.37	−1.6	14	6,004	ne.	26	e.	4	7	16	8	5.8		
East Gulf States.							68.7	+3.1										79	6.16	+3.4										4.1		
Atlanta	1,174	190	216	28.88	30.12	+.05	65.3	+2.9	84	3	73	38	9	58	25	58	54	75	6.45	+4.1	9	6,505	nw.	34	nw.	8	15	1	15	5.0		
Macon	370	78	87	29.69	30.09	+.03	67.6	+3.9	88	3	76	42	10	59	31	62	59	83	8.46	+6.3	10	3,559	n.	23	nw.	8	15	3	13	4.9		
Thomasville	273	8	57	29.76	30.05	+.01	70.6	+2.4	92	3	80	43	10	61	31	63	61	85	9.63	+6.2	10	3,502	ne.	16	sw.	1	13	7	11	4.9		
Pensacola	56	140	182	29.99	30.05	+.02	71.2	+1.8	86	1	78	47	9	65	20	65	62	78	7.80	+3.7	11	9,245	ne.	46	e.	13	14	5	12	4.7		
Anniston	741	9	57	29.33	30.12	+.05	65.2	+2.8	85	3	75	36	10	55	34				5.32	+3.0	9	3,083	se.	20	nw.	8	16	9	6	3.7		
Birmingham	700	11	48	29.36	30.12	+.05	66.9	+2.5	86	3	77	36	10	57	32	59	55	77	3.57	+1.2	8	4,053	n.	20	n.	8	16	8	7	3.7		
Mobile	57	125	161	29.99	30.05	+.01	70.9	+3.8	88	17	79	47	10	63	26	65	63	83	4.53	+1.4	9	7,020	n.	37	n.	8	17	9	5	3.8		
Montgomery	223	100	112	29.84	30.09	+.03	68.6	+2.9	89	3	77	41	10	60	28	62	58	78	6.80	+4.4	10	3,904	e.	25	n.	8	16	6	9	4.1		
Meridian	375	85	93	29.69	30.08	+.02	67.4	+4.4	87	3	78	39	10	57	33	60	58	81	1.40	−1.3	4	3,125	ne.	18	n.	8	20	5	6	3.6		
Vicksburg	247	65	74	29.82	30.10	+.04	68.4	+3.1	88	17	78	43	10	58	28	60	56	75	1.78	−1.0	5	3,854	se.	19	nw.	18	20	6	5	3.1		
New Orleans	51	76	84	29.99	30.04	+.01	73.4	+3.9	90	2	80	52	10	67	20	66	63	77	12.07	+9.1	8	4,701	ne.	28	se.	13	17	8	6	3.6		
West Gulf States.							68.8	+2.2										71	2.76	0.0										2.3		
Shreveport	249	77	93	29.82	30.09	+.04	67.9	+2.3	89	3	79	45	10	57	31	59	55	74	1.95	−1.2	4	3,875	n.	30	nw.	4	22	6	3	2.7		
Bentonville	1,303	11	44	28.72	30.09	+.04	59.8	+1.8	83	3	72	33	9	47	37				3.82	+1.0	6	3,656	s.	22	s.	3	21	7	3	2.5		
Fort Smith	457	79	94	29.60	30.08	+.03	64.4	+2.7	88	3	76	39	9	52	32	55	51	72	5.66	+2.8	5	4,629	e.	32	nw.	16	22	4	5	2.4		
Little Rock	357	139	147	29.72	30.09	+.03	65.4	+2.5	86	3	75	42	9	56	28	57	51	69	2.19	−0.4	6	5,368	nw.	26	s.	11	23	2	6	2.4		
Brownsville	57	3	40				75.2		94	4	87	55	7	63	32				0.82		5		n.									
Corpus Christi	20	69	77	30.03	30.05	+.05	74.5	+1.9	87	1	82	57	6	67	24	67	64	77	3.10	+1.0	1	7,318	se.	31	se.	15	20	10	1	2.5		
Dallas	512	109	117	29.53	30.08		67.6		90	3	80	45	6	55	31				1.98		5	5,813	se.	30	s.	3	24	3	4	2.1		
Fort Worth	670	106	114	29.35	30.06	+.03	67.6	+1.3	92	3	80	43	6	55	33	56	50	62	2.58	+0.1	5	6,349	se.	28	s.	11	22	2	7	2.5		
Galveston	54	106	114	30.01	30.07	+.04	74.2	+1.8	85	2	79	60	6	69	17	67	64	75	2.81	−1.4	2	6,726	n.	34	n.	5	23	7	1	2.1		
Houston	138	111	121	29.91	30.05		72.7	+2.8	90	3	83	52	6	62	26				1.08		4	4,927	se.	23	se.	11	24	5	2	2.0		
Palestine	510	64	72	29.54	30.07	+.04	69.2	+3.0	88	16	80	48	6	58	30	60	56	72	2.68	−0.9	2	3,460	ne.	15	s.	3	24	5	2	2.2		
San Antonio	701	109	132	29.33	30.06	+.05	72.2	+3.0	92	4	84	49	6	60	28	60	54	64	1.11	−0.4	3	5,174	s.	36	n.	4	23	8	0	2.0		
Taylor	582	55	63	29.49	30.10	+.08	69.2	+0.9	89	16	82	46	6	56	33				1.65	−0.9	2	5,111	n.	25	nw.	18	22	9	0	2.4		

TABLE I.—*Climatological data for United States Weather Bureau Stations, October, 1915*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.										Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles.								0-10		
Ohio Valley and Tennessee.							59.6	+ 2.8										74	2.19	− 0.4										4.0		
Chattanooga	762	189	213	29.32	30.14	+0.05	64.0	+ 3.2	84	17	74	37	10	55	31	56	53	75	3.36	+ 0.5	7	4,248	n.	30	s.	1	17	8	6	3.9	.....	....
Knoxville	996	93	100	29.07	30.13	+ .04	62.1	+ 4.0	84	17	73	33	10	51	35	55	51	76	2.68	+ 0.1	5	2,541	ne.	25	sw.	1	17	4	10	4.2	.....	....
Memphis	399	76	97	29.70	30.13	+ .06	65.6	+ 3.1	85	17	75	38	9	56	25	58	54	73	3.02	+ 0.3	4	4,849	n.	38	nw.	8	22	4	5	2.6	.....	....
Nashville	546	168	191	29.54	30.13	+ .05	63.0	+ 2.7	85	17	74	32	10	52	36	55	49	70	0.42	− 2.1	5	5,174	se.	35	nw.	8	17	9	5	3.5	.....	....
Lexington	989	193	230	29.06	30.13	+ .05	59.8	+ 3.3	79	3	68	34	9	51	28	....	....	....	0.81	− 1.4	5	8,415	s.	32	sw.	4	19	6	6	3.4	.....	....
Louisville	525	219	255	29.54	30.13	+ .05	61.2	+ 2.8	82	4	71	36	10	52	32	54	49	72	1.19	− 1.4	6	7,479	s.	35	s.	13	16	10	5	3.7	.....	....
Evansville	431	72	82	29.64	30.10	+ .02	61.8	+ 3.8	83	3	71	40	9	52	27	54	50	73	1.33	− 1.8	4	4,584	s.	28	s.	11	16	9	6	3.6	.....	....
Indianapolis	822	194	230	29.21	30.10	+ .03	57.6	+ 2.6	79	3	67	35	8	48	30	50	45	71	1.72	− 1.1	6	8,320	s.	37	ne.	1	14	9	8	4.6	.....	....
Terre Haute	575	96	129	29.47	30.09	......	58.5	......	82	3	69	35	9	48	30	51	46	74	1.00	......	6	6,623	s.	30	s.	31	13	10	8	4.6	.....	....
Cincinnati	628	11	51	29.43	30.11	+ .03	58.0	+ 1.0	82	4	68	30	10	48	35	51	46	72	2.36	0.0	5	4,587	s.	26	w.	8	17	8	6	3.8	.....	....
Columbus	824	173	222	29.23	30.11	+ .03	56.7	+ 2.6	82	4	66	33	10	47	33	50	46	75	0.94	− 1.4	7	7,547	s.	33	w.	8	15	10	6	3.5	.....	....
Dayton	899	181	216	29.13	30.10	......	57.1	+ 3.0	81	4	66	33	10	48	31	50	45	74	2.92	+ 0.5	5	6,841	s.	32	s.	13	15	9	7	4.3	T.	....
Pittsburgh	842	353	410	29.21	30.12	+ .04	56.2	+ 1.3	80	4	65	30	24	47	37	49	44	70	2.84	+ 0.5	9	7,129	nw.	36	e.	1	14	8	9	4.6	.....	....
Elkins	1,940	41	50	28.09	30.16	+ .06	54.2	+ 2.8	81	4	68	24	10	41	49	47	44	86	4.42	+ 2.0	8	2,137	w.	20	w.	29	9	9	13	5.7	T.	....
Parkersburg	638	77	84	29.48	30.14	+ .06	57.8	+ 3.2	80	4	68	28	10	47	38	51	48	80	2.64	+ 0.2	6	3,195	se.	18	nw.	5	16	10	5	4.2	.....	....
Lower Lake region.							53.4	+ 1.6										76	2.53	− 0.5										5.7		
Buffalo	767	247	280	29.23	30.07	+ .02	52.8	+ 1.3	79	4	59	33	24	46	32	48	44	78	2.11	− 1.4	11	12,115	sw.	52	w.	8	6	11	14	6.6	.....	....
Canton	448	10	61	29.58	30.06	......	50.4	+ 3.2	75	4	58	25	25	42	40	....	....	....	2.55	− 0.8	12	7,981	sw.	39	w.	5	8	10	13	6.2	T.	....
Oswego	335	76	91	29.69	30.06	+ .01	52.1	+ 0.9	75	4	59	32	25	45	31	47	44	77	3.94	+ 0.6	13	8,084	s.	29	nw.	22	6	15	10	6.0	.....	....
Rochester	523	97	113	29.51	30.09	+ .04	52.8	+ 2.0	81	4	60	32	25	45	33	47	42	74	2.78	− 0.1	13	5,559	sw.	28	sw.	26	5	13	13	6.5	.....	....
Syracuse	597	97	113	29.44	30.09	+ .03	51.7	+ 0.7	74	4	59	31	25	45	31	47	44	78	4.40	+ 1.2	14	8,547	s.	38	s.	25	8	5	18	6.6	T.	....
Erie	714	130	166	29.30	30.07	+ .02	54.5	+ 1.4	79	4	62	35	25	47	32	49	45	75	2.21	− 1.6	8	10,318	s.	47	sw.	31	9	12	10	5.5	.....	....
Cleveland	762	190	201	29.26	30.09	+ .03	55.4	+ 2.3	80	4	62	33	24	48	33	49	43	73	1.77	− 1.0	8	10,047	s.	42	s.	31	8	15	8	5.3	.....	....
Sandusky	629	62	103	29.40	30.09	+ .03	55.1	+ 1.2	81	4	63	33	10	47	32	49	46	77	2.84	+ 0.4	6	8,823	sw.	39	nw.	30	9	12	10	5.5	.....	....
Toledo	628	208	243	29.40	30.09	+ .04	54.8	+ 2.2	79	4	63	33	10	46	30	48	44	73	1.96	− 0.3	6	10,900	sw.	46	w.	26	15	10	6	4.1	.....	....
Fort Wayne	856	113	124	29.16	30.10	......	54.3	+ 0.6	78	3	63	33	8	45	27	48	45	78	1.45	......	7	6,790	sw.	34	sw.	26	10	9	12	5.5	.....	....
Detroit	730	218	245	29.27	30.07	+ .02	53.4	+ 1.7	77	4	61	35	24	46	25	48	44	75	0.78	− 1.6	5	8,145	sw.	42	sw.	26	12	11	8	4.5	.....	....
Upper Lake region.							49.9	+ 2.2										78	1.52	− 1.3										5.9		
Alpena	609	13	92	29.35	30.02	− .01	48.6	+ 2.7	70	4	56	31	24	41	29	44	41	79	1.64	− 1.8	8	8,896	sw.	35	s.	31	7	10	14	6.0	T.	....
Escanaba	612	54	60	29.31	29.99	− .02	47.2	+ 2.1	66	28	54	29	9	40	28	43	40	81	1.92	− 1.2	11	6,905	s.	29	nw.	28	8	9	14	6.1	T.	....
Grand Haven	632	54	92	29.34	30.03	.00	52.0	+ 1.8	75	3	59	33	10	45	24	47	43	77	0.94	− 1.6	6	9,369	s.	37	w.	26	12	12	7	4.7	T.	....
Grand Rapids	707	70	87	29.28	30.05	+ .01	52.8	+ 2.7	76	3	32	10	28	61	44	46	42	74	0.60	− 1.9	5	4,708	w.	26	w.	26	5	11	15	6.5	.....	....
Houghton	684	62	72	29.20	29.94	− .06	46.5	+ 1.4	70	15	52	31	9	40	28	....	....	....	3.09	− 0.1	12	6,393	w.	30	w.	28	4	8	19	7.5	0.3	....
Lansing	878	11	62	29.10	30.05	......	51.1	+ 2.4	76	3	61	28	10	41	31	45	42	81	0.70	− 1.5	8	4,539	sw.	24	sw.	26	9	11	11	5.5	T.	....
Ludington	637	60	66	29.31	30.01	......	50.8	......	72	3	57	31	24	44	25	47	44	81	2.52	......	9	8,886	s.	42	w.	26	13	7	11	5.5	0.4	....
Marquette	734	77	111	29.18	29.99	− .02	47.5	+ 1.6	69	16	53	32	24	42	22	42	38	74	2.67	− 0.5	15	7,859	sw.	33	nw.	8	6	9	16	7.1	0.7	....
Port Huron	638	70	120	29.36	30.06	+ .02	51.4	+ 1.9	75	4	60	29	24	43	30	46	43	80	1.00	− 1.7	6	8,192	sw.	37	w.	26	10	13	8	5.1	.....	....
Saginaw	641	48	82	29.35	30.05	......	51.0	......	74	3	60	28	24	42	27	46	44	83	0.75	− 2.0	8	7,012	s.	36	sw.	26	9	11	11	5.6	.....	....
Sault Ste. Marie	614	11	61	29.30	30.00	− .01	46.3	+ 2.9	66	3	53	28	24	40	27	43	40	83	2.36	− 0.9	13	6,899	se.	40	nw.	21	6	5	20	7.4	T.	....
Chicago	823	140	310	29.16	30.05	+ .01	56.4	+ 3.2	79	3	64	32	9	49	25	49	44	67	0.40	− 2.2	4	10,139	w.	39	sw.	31	13	9	9	4.5	.....	....
Green Bay	617	109	144	29.32	29.98	− .04	50.3	+ 3.2	70	3	59	28	9	42	29	44	40	76	0.85	− 1.5	6	8,551	s.	37	sw.	25	4	15	12	6.7	T.	....
Milwaukee	681	119	133	29.28	30.02	− .01	53.4	+ 3.2	72	31	61	34	9	46	28	47	42	73	1.22	− 1.2	3	7,877	sw.	31	sw.	25	11	11	9	4.7	T.	....
Duluth	1133	11	47	29.73	29.98	− .04	44.8	− 0.4	64	16	51	23	9	38	27	40	37	81	3.08	+ 0.3	7	10,401	ne.	53	w.	7	10	8	13	5.6	0.3	....
North Dakota.							47.6	+ 5.0										71	1.13	− 0.2										4.3		
Moorhead	940	8	57	28.94	29.97	− .03	48.4	+ 5.6	79	22	61	24	8	36	41	41	37	76	0.96	− 1.1	5	7,002	nw.	40	nw.	25	23	2	6	3.2	.....	....
Bismarck	1674	8	57	28.20	30.00	+ .01	48.6	+ 4.5	80	22	62	21	8	35	41	40	35	71	1.52	+ 0.5	5	7,020	nw.	48	w.	24	17	7	7	4.1	T.	....
Devils Lake	1482	11	44	28.34	29.93	− .06	45.4	+ 4.9	73	1	58	20	8	33	39	38	33	72	0.45	− 0.8	5	8,442	w.	48	w.	25	11	13	7	5.1	0.8	....
Williston	1872	40	47	27.96	29.95	− .03	47.9	+ 5.0	78	21	61	24	8	34	43	40	34	66	1.60	+ 0.8	5	5,404	nw.	44	nw.	24	11	14	6	4.9	T.	....
Upper Mississippi Valley.							55.9	+ 3.1										70	1.12	− 1.3										4.2		
Minneapolis	918	10	208	28.96	29.94	......	51.4	......	75	22	60	30	9	43	32	....	....	....	2.59	0.0	8	9,243	s.	43	w.	25	13	7	11	5.2	T.	
St. Paul	837	201	236	29.05	29.97	− .04	50.6	+ 2.5	73	22	59	28	9	42	35	....	....	....	1.59	− 0.8	9	9,532	se.	49	nw.	25	11	11	9	5.1	0.2	....
La Crosse	714	11	48	29.21	29.99	− .03	52.0	+ 2.1	72	22	62	25	9	42	35	....	....	....	1.81	− 0.6	11	4,055	s.	24	sw.	25	11	5	15	6.0	T.	....
Madison	974	70	78	28.98	30.03	.00	51.8	+ 3.0	76	3	60	27	9	43	30	46	40	72	0.48	− 1.9	4	7,089	s.	27	s.	3	12	5	14	5.6	T.	....
Charles City	1015	10	49	28.92	30.01	− .01	51.8	+ 3.6	76	23	63	23	9	41	42	45	42	81	2.03	0.0	10	5,458	se.	26	nw.	25	15	8	8	4.3	.....	....
Davenport	606	71	79	29.38	30.04	.00	55.8	+ 3.2	80	3	66	28	9	45	35	48	43	72	0.36	− 2.0	4	5,400	w.	26	nw.	26	18	6	7	3.8	T.	....
Des Moines	861	84	97	29.10	30.01	− .02	56.8	+ 4.3	80	24	68	28	9	46	38	48	42	65	0.43	− 2.2	4	5,485	s.	31	sw.	6	13	9	9	4.5	.....	....
Dubuque	698	81	96	29.29	30.04	.00	54.0	+ 2.0	78	3	64	26	9	44	35	47	41	71	2.03	− 0.6	6	4,633	s.	22	s.	10	14	8	9	5.1	T.	....
Keokuk	614	64	78	29.38	30.06	+ .01	57.7	+ 3.2	83	3	69	29	9	46	36	50	44	70	0.38	− 2.1	2	5,374	s.	30	sw.	3	19	8	4	3.1	.....	....
Cairo	356	87	93	29.71	30.09	+ .02	63.2	+ 4.1	83	3	73	36	9	54	28	54	50	71	1.20	− 1.4	3	5,219	s.	27	nw.	8	20	6	5	2.8	.....	....
Peoria	609	11	45	29.40	30.07	+ .02	55.6	+ 3.6	81	3	68	26	9	43	40	48	44	76	0.55	− 2.0	5	4,618	s.	30	sw.	31	14	8	9	4.3	.....	....
Springfield, Ill	644	10	91	29.38	30.08	+ .02	57.7	+ 3.1	81	3	68	33	9	47	32	49	42	65	0.73	− 1.9	4	5,885	s.	26	nw.	8	20	6	6	3.2	.....	....
Hannibal	534	74	109	29.50	30.07	+ .02	57.8	+ 1.9	84	3	70	29	9	45	39	....	....	....	0.58	− 1.1	4	6,262	sw.	33	sw.	31	22	6	3	2.6	.....	....
St. Louis	567	265	303	29.47	30.08	+ .02	61.7	+ 3.3	82	3	71	37	9	52	26	52	45	61	0.90	− 1.5	4	9,500	s.	43	s.	31	22	6	3	2.5	.....	....
Missouri Valley.							57.1	+ 4.4										66	1.24	− 0.7										3.4		
Columbia, Mo	781	11	84	29.24	30.07	+ .02	58.8	+ 4.0	85	3	71	29	9	46	39	....	....	....	1.37	− 1.0	5	5,286	s.	28	sw.	31	20	6	5	2.7	.....	....
Kansas City	963	161	181	29.02	30.05	+ .01	62.0	+ 6.2	82	3	72	38	9	52	29	51	43	57	0.35	− 1.9	4	8,492	s.	34	nw.	7	23	6	2	2.4	.....	....
St. Joseph	967	11	49	29.00	30.04	......	59.8	......	81	24	71	29	9	49	35	50	44	66			5	5,793	s.	29	nw.	7	17	10	4	3.1	.....	....
Springfield, Mo	1,324	98	104	28.69	30.10	+ .05	60.4	+ 3.1	82	3	70	34	9	50	27	50	44	64	2.56	− 0.2	6	7,001	s.	38	se.	16	25	5	1	1.7	.....	....
Iola	984	11	50	29.03	30.08	+ .06	59.4	+ 2.5	83	3	73	30	9	46	39	....	....	....	1.00	− 1.3	4	4,639	s.	27	sw.	10	23	4	4	2.3	.....	....
Topeka	983	85	101	....	....	......	60.0	+ 3.7	82	29	72	31	9	48	37	....	....	....	0.76	− 1.2	4	7,240	s.	37	s.	10	21	8	2	2.5	.....	....
Drexel	1,299	10	53	28.62	30.02	......	55.8	......	80	3	67	29	9	44	36	47	42	69	0.75	......	5	8,395	nw.	40	sw.	30	13	10	8	4.5	.....	....
Lincoln	1,189	11	84	28.75	30.01	− .02	58.0	+ 4.7	84	23	70	28	9	45	36	48	42	72	1.55	− 0.3	4	7,628	s.	36	nw.	6	20	8	3	3.0	.....	....
Omaha	1,105	115	121	28.83	30.01	− .02	58.2	+ 4.0	82	23	68	33	8	48	32	49	42	66	0.89	− 1.5	4	5,692	s.	24	nw.	31	16	11	4	3.7	.....	....
Valentine	2,598	47	54	27.30	30.02	+ .01	53.3	+ 4.8	86	22	68	23	8	38	46	42	34	60	1.54	+ 0.2	4	7,001	w.	38	w.	24	20	7	4	3.4	.....	....
Sioux City	1,135	94	164	28.78	30.00	− .02	54.8	+ 3.7	78	10	66	28	9	44	34	47	42	71	1.42	− 0.4	5	9,335	nw.	46	s.	30	18	4	9	4.0	.....	....
Huron	1,306	59	74	28.61	30.01	.00	51.3	+ 7.6	81	22	64	25	8	38	38	43	39	74	1.06	− 0.3	7	8,562	nw.	42	w.	24	13	10	8	4.5	.....	....
Pierre	1,572	70	75	28.35	30.02	+ .01	53.8	+ 4.7	82	22	67	27	8	41	39	44	36	62	1.20	+ 0.4	8	6,349	nw.	51	w.	24	12	13	6	4.7	.....	....
Yankton	1,233	49	57	28.66	29.98	− .03	54.8	+ 4.3	83	10	66	29	8	43	42	....	....	....	1.18	− 0.4	7	5,816	nw.	36	nw.	3	12	11	8	4.9	.....	....

TABLE I.—*Climatological data for United States Weather Bureau Stations, October, 1915*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.									Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.						
	Ft.	Ft.	t.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles.								0-10		
Northern Slope.							49.5	+ 4.8										60	0.69	− 0.2										4.6		
Havre	2,505	11	44	27.31	29.95	+0.01	49.2	+ 5.6	82	22	63	23	7	36	48	42	36	69	0.42	− 0.1	4	6,602	nw.	48	w.	30	7	15	9	5.6	.....	....
Helena	4,110	87	114	25.83	30.04	+ .07	49.7	+ 5.7	78	22	62	27	7	38	36	39	31	55	0.33	− 0.5	4	6,185	sw.	46	sw.	23	8	16	7	5.5	2.2	....
Kalispell	2,962	11	34	26.97	30.04	+ .03	46.2	+ 3.7	70	20	58	26	11	34	36	40	35	72	0.34	− 0.8	8	3,366	sw.	28	sw.	26	7	15	9	5.9	.....	....
Miles City	2,371	26	48	27.48	30.05	+ .05	52.4	+ 5.9	82	21	66	25	8	38	44	43	38	71	0.84	+ 0.1	6	3,520	s.	34	w.	24	19	9	3	3.4	.....	....
Rapid City	3,259	50	58	26.62	30.04	+ .08	52.4	+ 5.8	82	23	66	22	8	30	46	42	32	52	1.69	+ 0.6	5	6,299	w.	39	n.	30	11	15	5	4.5	.....	....
Cheyenne	6,088	84	101	24.08	30.06	+ .10	48.0	+ 2.7	75	9	61	21	7	35	37	37	26	50	1.11	+ 0.4	4	9,684	w.	58	w.	31	12	12	7	4.8	1.0	....
Lander	5,372	60	68	24.72	30.09	+ .13	48.6	+ 6.4	78	9	65	21	7	32	47	37	25	49	0.09	− 1.0	3	3,462	sw.	32	nw.	24	11	19	1	4.3	.....	....
Sheridan	3,790	10	47	26.14	30.07	......	48.4	......	81	23	66	20	7	31	49	38	31	65	0.43	......	6	3,965	s.	54	nw.	24	13	14	4	4.3	.....	....
Yellowstone Park	6,200	11	48	23.96	30.10	+ .08	44.0	+ 2.5	72	22	56	19	7	32	39	34	26	56	0.34	− 0.8	5	6,543	s.	37	s.	5	12	7	12	5.1	1.6	....
North Platte	2,821	11	51	27.13	30.07	+ .10	54.6	+ 4.6	86	10	71	27	8	39	46	43	36	65	1.07	− 0.1	3	4,979	s.	32	n.	24	20	6	5	3.0	.....	....
Middle Slope.							58.0	+ 2.5										60	1.73	+ 0.2										2.5		
Denver	5,291	129	172	24.80	30.05	+ .09	54.2	+ 3.2	83	9	68	31	8	40	37	41	28	44	1.25	+ 0.3	4	5,938	sw.	38	nw.	3	20	7	4	3.1	2.0	....
Pueblo	4,685	80	86	25.36	30.05	+ .09	54.0	+ 1.7	87	2	71	28	12	37	54	40	28	44	0.41	− 0.3	2	3,996	nw.	28	w.	31	23	6	2	2.1	.....	....
Concordia	1,392	50	58	28.56	30.04	+ .05	58.4	+ 3.0	84	29	70	35	8	46	39	49	44	70	3.40	+ 1.4	4	5,652	s.	31	s.	10	16	11	4	3.5	.....	....
Dodge	2,509	11	51	27.47	30.08	+ .06	58.0	+ 3.3	84	10	72	33	5	44	45	48	43	72	0.81	− 0.6	2	6,582	s.	30	sw.	30	25	3	3	1.6	.....	....
Wichita	1,358	139	158	28.60	30.04	+ .04	60.8	+ 2.0	82	28	72	37	9	50	33	51	45	63	1.66	− 0.6	3	9,112	s.	42	s.	10	23	5	3	2.2	.....	....
Oklahoma	1,214	10	47	28.80	30.08	+ .09	62.9	+ 1.6	86	3	75	40	5	51	32	52	48	70	2.84	+ 1.0	4	8,542	s.	40	s.	11	23	4	4	2.5	.....	....
Southern Slope.							63.7	+ 1.2										63	0.75	− 1.2										2.2		
Abilene	1,738	10	52	28.25	30.06	+ .10	65.4	+ 1.2	89	3	78	42	5	52	37	55	50	69	1.33	− 1.0	1	6,119	s.	32	s.	11	22	7	2	2.4	.....	....
Amarillo	3,676	10	49	26.34	30.06	+ .10	59.0	+ 2.9	83	2	72	37	26	46	36	48	43	68	1.55	− 0.2	4	7,735	sw.	30	sw.	30	28	3	0	2.6	.....	....
Del Rio	944	64	71	29.05	30.03	+ .05	70.3	+ 0.4	88	3	82	47	6	59	31	....	....	....	0.01	− 2.0	1	5,262	se.	28	se.	14	21	9	1	2.5	.....	....
Roswell	3,566	75	85	26.44	30.03	+ .11	60.0	+ 0.5	88	2	77	35	26	43	46	47	36	51	0.12	− 1.4	3	4,724	s.	29	sw.	11	28	3	0	1.1	.....	....
Southern Plateau.							61.8	+ 1.9										39	0.04	− 0.5										0.8		
El Paso	3,762	110	133	26.25	29.98	+ .10	63.9	+ 1.5	87	2	78	43	27	49	38	48	34	41	0.18	− 0.8	2	5,615	se.	46	w.	11	28	3	0	0.7	.....	....
Santa Fe	7,013	57	62	23.35	30.04	+ .08	52.0	+ 2.0	73	29	65	32	12	38	33	37	24	42	0.04	− 1.0	2	4,648	se.	24	sw.	3	24	5	2	1.9	.....	....
Flagstaff	6,908	8	57	23.45	30.03	+ .11	46.8	+ 2.1	76	19	67	20	12	27	50	....	....	....	....	....	2	......	e.	33	sw.	10	28	2	1	....	.....	....
Phoenix	1,108	76	81	28.76	29.90	+ .09	73.8	+ 3.6	100	7	90	48	16	57	43	55	40	33	T.	− 0.4	0	3,396	e.	23	nw.	11	29	2	0	0.9	.....	....
Yuma	141	9	54	29.73	29.88	+ .10	75.4	+ 3.0	104	8	95	49	12	56	49	57	44	41	T.	− 0.2	0	3,038	n.	19	n.	11	31	0	0	0.2	.....	....
Independence	3,910	11	42	26.00	29.98	+ .03	58.7	− 0.6	88	5	77	34	17	40	43	44	30	38	0.00	− 0.3	0	3,350	se.	28	se.	22	31	0	0	0.3	.....	....
Middle Plateau.							53.2	+ 2.5										36	0.02	− 0.8										1.6		
Reno	4,532	74	81	25.56	30.06	+ .07	54.8	+ 5.1	87	7	73	29	12	36	47	40	25	37	T.	− 0.4	0	3,982	w.	32	w.	9	27	3	1	1.5	.....	....
Tonopah	6,090	12	20	24.17	30.04	− .01	55.8	......	78	7	66	29	11	46	26	40	23	30	0.00	− 0.8	0	5,907	se.	36	nw.	2	26	4	1	1.2	.....	....
Winnemucca	4,344	18	56	25.71	30.12	+ .07	50.2	+ 1.6	85	8	72	20	24	29	53	37	24	44	0.05	− 0.5	1	4,032	ne.	26	w.	23	28	2	1	0.8	.....	....
Modena	5,479	10	43	24.71	30.07	+ .11	50.6	+ 0.5	82	8	70	22	12	31	49	36	19	34	0.07	− 0.8	2	7,152	w.	39	s.	9	26	2	3	1.5	.....	....
Salt Lake City	4,360	147	189	25.71	30.08	+ .07	56.3	+ 4.1	82	9	67	37	12	45	32	42	28	37	0.01	− 1.4	1	5,140	se.	36	n.	10	24	3	4	2.4	.....	....
Grand Junction	4,602	82	96	25.47	30.06	+ .07	54.3	+ 1.0	79	2	69	33	31	40	38	40	25	37	0.01	− 0.9	1	4,374	se.	29	w.	2	24	5	2	2.0	.....	....
Northern Plateau.							53.0	+ 3.6										49	0.47	− 0.8										5.0		
Baker	3,471	48	53	26.54	30.14	+ .06	49.2	+ 3.7	77	8	64	24	11	34	41	39	26	46	0.05	− 0.9	5	4,713	se.	24	sw.	31	12	13	6	4.3	.....	....
Boise	2,739	78	86	27.25	30.12	+ .06	54.4	+ 4.1	83	21	68	30	11	41	40	43	29	43	0.21	− 1.1	4	3,164	nw.	26	nw.	23	16	10	5	3.5	.....	....
Lewiston	757	40	48	29.26	30.08	+ .01	54.0	+ 2.2	77	1	66	33	16	42	39	....	....	....	1.05	− 0.2	4	2,162	w.	25	sw.	31	6	10	15	6.5	.....	....
Pocatello	4,477	46	54	25.56	30.08	+ .04	52.6	+ 4.6	79	21	66	29	12	39	43	40	27	42	0.11	− 0.9	3	6,587	se.	44	sw.	23	18	10	3	3.4	.....	....
Spokane	1,929	101	110	28.01	30.07	+ .01	50.9	+ 3.6	73	21	61	29	6	41	36	43	36	61	0.43	− 1.1	6	4,939	sw.	44	sw.	31	4	10	17	7.1	.....	....
Walla Walla	1,000	57	65	28.99	30.06	− .01	56.8	+ 3.1	76	1	67	38	6	47	30	48	39	55	0.99	− 0.5	7	3,646	s.	25	sw.	31	12	7	12	5.4	.....	....
North Pacific Coast region.							53.0	+ 1.9										80	4.49	+ 0.5										7.1		
North Head	211	11	56	29.86	30.09	+ .04	53.8	+ 0.9	72	6	57	44	19	50	23	52	50	87	4.49	+ 0.6	17	14,412	se.	71	se.	30	7	6	18	6.7	.....	....
Port Crescent	259	8	53	29.78	30.07	+ .05	48.1	+ 0.7	64	1	55	34	4	41	23	....	....	....	5.06	+ 1.6	16	3,425	s.	22	se.	24	2	7	22	8.0	.....	....
Seattle	125	215	250	29.96	30.09	+ .04	53.7	+ 2.9	69	7	60	43	19	48	25	50	46	79	3.00	+ 0.1	17	8,278	s.	58	sw.	21	1	8	22	8.2	.....	....
Tacoma	213	113	120	29.86	30.09	+ .05	53.4	+ 2.8	72	7	60	36	6	46	32	50	46	79	3.44	0.0	14	4,696	sw.	30	sw.	2	0	15	16	7.6	.....	....
Tatoosh Island	109	7	57	29.93	30.02	+ .01	51.4	+ 1.5	60	6	55	44	24	48	16	50	48	91	12.50	+ 4.5	20	13,493	s.	71	s.	27	2	10	19	8.0	.....	....
Portland, Oreg.	153	68	106	29.94	30.10	+ .04	55.8	+ 2.5	74	7	63	38	11	48	26	51	46	73	1.98	− 1.7	15	4,294	s.	25	sw.	2	6	7	18	6.8	.....	....
Roseburg	510	9	57	29.58	30.14	+ .06	54.6	+ 1.8	82	7	67	34	12	42	42	48	43	72	0.94	− 1.7	9	1,473	nw.	16	sw.	22	9	17	5	4.6	.....	....
Middle Pacific Coast region.							60.6	+ 1.8										58	0.22	− 1.4										2.6		
Eureka	62	73	89	30.06	30.13	+ .07	52.3	− 0.8	72	21	59	40	6	46	27	49	47	87	0.79	− 1.9	4	3,788	n.	36	n.	3	13	7	11	4.9	.....	....
Mount Tamalpais	2,375	11	18	27.60	30.05	+ .04	63.1	+ 4.4	82	5	70	45	23	56	29	49	34	40	0.36	− 1.6	2	12,018	nw.	60	n.	1	22	8	1	1.7	.....	....
Point Reyes Light	490	7	18	29.49	30.01	......	54.4	− 0.3	77	28	59	44	1	50	25	....	....	....	0.08	......	2	13,824	n.	60	nw.	10	14	5	12	4.7	.....	....
Red Bluff	332	50	56	29.65	30.00	− .03	66.4	+ 2.6	91	6	81	45	24	52	38	51	35	36	0.15	− 1.4	1	3,881	nw.	31	nw.	3	24	7	0	1.5	.....	....
Sacramento	69	106	117	29.93	30.00	+ .01	65.2	+ 3.0	91	5	80	44	10	50	38	52	40	48	T.	− 1.0	0	4,803	se.	27	nw.	2	28	3	0	0.9	.....	....
San Francisco	155	209	213	29.86	30.03	+ .02	61.3	+ 2.9	85	3	70	49	20	52	31	53	50	78	0.01	− 1.3	1	5,682	sw.	33	sw.	17	21	7	3	2.7	.....	....
San Jose	141	12	110	29.88	30.03		61.2	+ 0.9	89	4	76	39	24	46	40				0.00	− 0.9	0	2,315	nw.	18	s.	29	25	6	0	1.8	.....	....
South Pacific Coast region.							64.0	+ 1.7										69	0.00	− 0.8										1.9		
Fresno	327	89	98	29.64	29.99	+ .03	67.4	+ 2.7	94	5	84	44	31	51	39	53	40	43	0.00	− 0.7	0	4,102	nw.	22	nw.	2	30	1	0	0.4	.....	....
Los Angeles	338	159	191	29.62	29.98	+ .03	65.2	+ 2.9	92	28	76	47	25	54	33	56	51	72	0.00	− 0.8	0	3,298	sw.	15	s.	11	23	8	0	2.0	.....	....
San Diego	87	62	70	29.88	29.97	+ .02	62.8	− 0.2	80	19	69	52	24	56	28	58	56	85	0.00	− 0.5	0	4,144	nw.	23	nw.	30	25	6	0	2.4	.....	....
San Luis Obispo	201	32	40	29.82	30.04	+ .05	60.6	+ 1.4	94	28	75	39	19	47	50	52	48	75	0.00	− 1.3	0	2,402	n.	24	ne.	24	24	6	1	2.7	.....	....
West Indies.																																
San Juan	82	8	54	29.81	29.89	− .01	81.3	......	93	30	87	73	12	76	17	......	......		1.61	− 4.5	14	6,043	s.	31	ne.	14	16	14	1	3.6		
Panama.																																
Balboa Heights	118	7	97	29.71	29.83	......	79.1	......	89	15	84	72	25	74	15	75	75	92	10.51	0.0	25	4,695	nw.	35	nw.	23	0	0	31	9.4		
Colon	25	5	71	29.80	29.83	......	80.8	......	90	26	86	74	16	76	15	77	76	90	21.86	+ 7.1	29	5,436	se.	30	sw.	31	0	11	20	7.9		

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during October, 1915, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex.	17	9:30 a.m.	7:00 p.m.	0.99	1:02 p.m.	1:29 p.m.	0.12	0.16	0.28	0.36	0.46	0.59	0.65								
Albany, N. Y.	14-15	8:15 p.m.	6:40 a.m.	1.10	5:10 a.m.	5:22 a.m.	.46	.22	.49	.54											
Alpena, Mich.	17-18			1.33														0.31			
Amarillo, Tex.	14-15	5:15 p.m.	3:30 a.m.	1.19	8:06 p.m.	8:17 p.m.	.38	.17	.33	.35											
Anniston, Ala.	14	1:18 p.m.	3:07 p.m.	1.27	1:31 p.m.	1:55 p.m.	.01	.17	.35	.61	.83	.95									
	18-19	D. N. p.m.	6:15 a.m.	1.50	4:16 a.m.	4:41 a.m.	.72	.06	.11	.18	.31	.50									
Asheville, N. C.	4-5			1.49														.50			
Atlanta, Ga.	4	4:55 p.m.	7:15 p.m.	1.32	5:30 p.m.	6:31 p.m.	.01	.16	.27	.39	.46	.53	.57	0.58	0.63	0.68	0.87	1.12	1.23		
Atlantic City, N. J.	14-15	7:38 p.m.	D. N. a.m.	0.97	2:28 a.m.	2:59 a.m.	.13	.14	.38	.47	.52	.64	.74	.76							
Augusta, Ga.	4-5	10:00 a.m.	D. N. a.m.	1.25	11:40 p.m.	12:06 a.m.	.39	.15	.32	.36	.42	.58	.63								
	19-20	3:15 p.m.	7:05 p.m.	0.88	5:38 p.m.	5:52 p.m.	.20	.35	.51	.58											
	19-20	8:55 p.m.	9:40 a.m.	2.94	2:48 a.m.	3:13 a.m.	1.82	.23	.39	.48	.64	.74									
Baker, Oreg.				0.01														T.			
Baltimore, Md.	1			2.23														.40			
Bentonville, Ark.	3-4	10:35 p.m.	5:10 a.m.	1.18	12:04 a.m.	12:09 a.m.	.36	.25													
Binghamton, N. Y.	15			0.42														.36			
Birmingham, Ala.	14	9:02 a.m.	12:01 p.m.	0.87	10:53 a.m.	11:19 a.m.	.36	.12	.22	.29	.37	.47	.49								
Bismarck, N. Dak.	3			0.93														.13			
Block Island, R. I.	19-20			2.10														.49			
Boise, Idaho	13-14			0.13														.06			
Boston, Mass.	15			0.70														.65			
Buffalo, N. Y.	14			0.52														.17			
Burlington, Vt.	5			1.02														.33			
Cairo, Ill.	13-14			0.96														.28			
Canton, N. Y.	5			0.71														.37			
Charles City, Iowa	16-17			0.59														.35			
Charleston, S. C.	5	D. N. a.m.	D. N. a.m.	1.00	3:49 a.m.	4:19 a.m.	.08	.37	.50	.58	.67	.78	.85								
Charlotte, N. C.	19-21			1.27														.37			
Chattanooga, Tenn.	4			1.03														.70			
Cheyenne, Wyo.	15-16			0.97														.15			
Chicago, Ill.	17			0.30														.11			
Cincinnati, Ohio	4	12:58 p.m.	1:58 p.m.	0.53	1:24 p.m.	1:36 p.m.	.05	.17	.39	.42											
Cleveland, Ohio	14			1.10														.28			
Columbia, Mo.	12			0.63														.34			
Columbia, S. C.	4-7			2.62														.45			
Columbus, Ohio	1			0.33														.12			
Concord, N. H.	26			0.74														.38			
Concordia, Kans.	15	12:02 p.m.	5:41 p.m.	2.29	2:34 p.m.	4:55 p.m.	.23	.11	.20	.26	.30	.32	.38	.46	.49	.55	.61				
								.68	.73	.77	.83	.89	.95	1.05	1.12	1.15	1.19				
								1.25	1.30	1.34	1.39	1.46	1.74	1.81	1.80	1.92					
Corpus Christi, Tex.	4-5	9:30 p.m.	D. N. a.m.	3.10	9:39 p.m.	10:23 p.m.	.03	.35	.76	1.16	1.55	2.03	2.36	2.60	2.75	2.83					
Davenport, Iowa	12-13			0.28														.15			
Dayton, Ohio	4	3:23 p.m.	4:12 p.m.	1.30	3:29 p.m.	3:53 p.m.	.02	.29	.73	.93	1.13	1.27									
Del Rio, Tex.	19			0.01														.01			
Denver, Colo.	15-16			0.86														*			
Des Moines, Iowa	12			0.19														.09			
Detroit, Mich.	1			0.41														.14			
Devils Lake, N. Dak.	24-25			0.26														.14			
Dodge City, Kans.	14-15			0.81														.20			
Dubuque, Iowa	17	2:15 p.m.	5:07 p.m.	1.42	3:33 p.m.	4:00 p.m.	.25	.12	.38	.68	.89	1.01	1.05								
Duluth, Minn.	3-4			1.79														.35			
Eastport, Me.	5			0.60														.15			
Elkins, W. Va.	18			1.50														.74			
El Paso, Tex.	14-15			0.18														.10			
Erie, Pa.	14			1.04														.30			
Escanaba, Mich.	3			0.26														.19			
Eureka, Cal.	22-23			0.70														.32			
Evansville, Ind.	13-14			0.76														.32			
Flagstaff, Ariz.	15			0.16														*			
Fort Smith, Ark.	16	D. N. a.m.	12:16 p.m.	1.66	1:31 a.m.	2:08 a.m.	.01	.10	.14	.15	.23	.39	.50	.60	.68						
	16-17	7:40 p.m.	11:02 a.m.	2.99	8:14 p.m.	8:52 p.m.	.01	.13	.23	.35	.43	.48	.51	.58	.66						
					2:37 a.m.	3:25 a.m.	1.48	.10	.22	.36	.48	.53	.57	.60	.64	.72	.78				
Fort Wayne, Ind.	17			0.47														.43			
Fort Worth, Tex.	17	3:22 p.m.	6:27 p.m.	1.62	4:12 p.m.	5:26 p.m.	.13	.06	.19	.40	.50	.59	.70	.83	.87	.88	.88	.90	1.30		
Fresno, Cal.	‡																				
Galveston, Tex.	4	12:05 p.m.	D. N. p.m.	2.20	12:37 p.m.	2:35 p.m.	.03	.08	.21	.35	.47	.57	.60	.63	.65	.70	.72	.78	1.18	1.63	1.86
Grand Haven, Mich.	17			0.33														.13			
Grand Junction, Colo.	15			0.01														.01			
Grand Rapids, Mich.	13			0.23														.11			
Green Bay, Wis.	13			0.31														.15			
Hannibal, Mo.	12			0.27														.22			
Harrisburg, Pa.	5			0.37														.30			
Hartford, Conn.	1-2			1.43														.26			
Hatteras, N. C.	7	9:05 a.m.	11:10 a.m.	0.56	10:08 a.m.	10:28 a.m.	.09	.14	.21	.32	.43										
Havre, Mont.	2-3			0.31														.12			
Helena, Mont.	5			0.18														*			
Houghton, Mich.	3			0.98														.46			
Houston, Tex.	4	7:40 p.m.	9:15 p.m.	0.79	7:45 p.m.	7:58 p.m.	.01	.14	.43	.53											
Huron, S. Dak.	16			0.61														.15			
Independence, Cal.	‡																				
Indianapolis, Ind.	17	6:32 p.m.	9:00 p.m.	0.85	8:05 p.m.	8:35 p.m.	.08	.14	.42	.58	.66	.68	.77								
Iola, Kans.	15-16			0.59														.25			
Jacksonville, Fla.	6	2:28 p.m.	6:15 p.m.	0.65	3:17 p.m.	3:29 p.m.	.02	.36	.57	.62											
	13	3:14 p.m.	6:50 p.m.	1.38	3:14 p.m.	4:15 p.m.	.00	.40	.66	.72	.75	.78	.81	.95	1.00	1.02	1.03	1.27	1.30		
Kalispell, Mont.	1			0.13														.04			
Kansas City, Mo.	12			0.25														.15			
Keokuk, Iowa	12			0.33														.13			
Key West, Fla.	25			0.95														.70			
Knoxville, Tenn.	19			1.10														.57			
La Crosse, Wis.	17			0.51														.32			
Lander, Wyo.	14-15			0.07														.03			
Lansing, Mich.	17-18			0.36														.18			
Lewiston, Idaho	2-3			0.93														.30			
Lexington, Ky.	18			0.60														.21			
Lincoln, Nebr.	15-16			1.16														.31			
Little Rock, Ark.	12-13	9:10 p.m.	7:10 a.m.	1.35	11:10 p.m.	11:35 p.m.	.19	.16	.35	.44	.63	.82									
Los Angeles, Cal.	‡																				
Louisville, Ky.	18			0.61														.31			

* Self-register not working. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during October, 1915, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Ludington, Mich.	17			1.62														0.40			
Lynchburg, Va.	19-20			0.63														*			
Macon, Ga.	4	12:00 m.	2:10 p. m.	1.00	12:26 p. m.	12:58 p. m.	0.07	0.09	0.19	0.44	0.62	0.74	0.85	0.88							
	4	2:55 p. m.	D. N. p. m.	2.06	5:05 p. m.	5:49 p. m.	.17	.05	.19	.36	.46	.67	.81	.87	0.95	0.98					
	19	3:03 p. m.	5:50 p. m.	1.53	3:23 p. m.	3:53 p. m.	.02	.11	.54	.82	.84	.99	1.06								
	20	D. N. a. m.	10:30 a. m.	1.10	1:37 a. m.	2:12 a. m.	.04	.16	.23	.47	.55	.64	.78	.88							
	22	2:25 a. m.	D. N. a. m.	1.19	2:45 a. m.	3:05 a. m.	.01	.22	.38	.60	.76										
Madison, Wis.	17			0.32														.27			
Marquette, Mich.	3			0.51														.29			
Memphis, Tenn.	18	D. N. a. m.	8:45 a. m.	1.61	2:48 a. m.	3:29 a. m.	.05	.22	.36	.52	.71	.80	.84	.91	.98	1.02					
Meridian, Miss.	4			1.00														.38			
Miami, Fla.	26-27	9:00 p. m.	3:15 p. m.	5.81	9:50 p. m.	10:23 p. m.	.02	.06	.17	.29	.44	.53	.64	.70							
					3:57 a. m.	5:39 a. m.	1.47	.13	.39	.79	1.13	1.42	1.69	1.96	2.15	2.24	2.28	2.30	2.51	2.80	2.92
Milwaukee, Wis.	17			0.66														.38			
Minneapolis, Minn.	3	1:27 p. m.	5:20 p. m.	1.41	1:33 p. m.	1:47 p. m.	.20	.28	.51	.59											
					4:23 p. m.	4:31 p. m.	1.09	.25	.29												
Mobile, Ala.	3	6:10 p. m.	D. N. p. m.	0.51	8:07 p. m.	8:18 p. m.	.10	.20	.32	.35											
Modena, Utah	15			0.05														.02			
Montgomery, Ala.	15	3:07 p. m.	4:25 p. m.	1.12	3:40 p. m.	4:02 p. m.	.06	.10	.28	.73	1.01	1.05									
	18-19	7:35 p. m.	7:10 a. m.	1.90	10:15 p. m.	10:25 p. m.	.43	.18	.33												
					5:26 a. m.	5:55 a. m.	.93	.07	.21	.37	.55	.61	.73								
Moorhead, Minn.	3			0.61														.14			
Mount Tamalpais, Cal.	22-23			0.36														.09			
Nantucket, Mass.	6			0.55														.34			
Nashville, Tenn.	14			0.14														.12			
New Haven, Conn.	26			0.29														.29			
New Orleans, La.	12-13	7:55 a. m.	1:20 p. m.	7.84	12:38 p. m.	1:27 p. m.	.25	.06	.21	.41	.53	.93	1.32	1.48	1.54	1.71	1.79				
					2:19 p. m.	3:53 p. m.	2.43	.15	.30	.47	.55	.62	.94	1.30	1.59	1.69	1.83	2.01	2.55	2.81	
New York, N. Y.	26-27			0.35														.32			
Norfolk, Va.	5	12:27 p. m.	1:10 p. m.	0.53	12:30 p. m.	12:51 p. m.	.02	.22	.25	.41	.49	.51									
Northfield, Vt.	5			0.45														.23			
North Head, Wash.	24-25			0.79														.16			
North Platte, Nebr.	14-16			1.07														.13			
Oklahoma, Okla.	16	3:55 p. m.	4:35 p. m.	0.59	4:22 p. m.	4:30 p. m.	.01	.35	.58												
Omaha, Nebr.	15-16			0.31														.14			
Oswego, N. Y.	5	12:15 a. m.	8:25 a. m.	1.57	4:31 a. m.	5:10 a. m.	.62	.12	.19	.30	.34	.44	.49	.62	.67						
Palestine, Tex.	17-18	9:20 p. m.	11:50 a. m.	2.59	9:37 p. m.	10:01 p. m.	.02	.24	.56	.90	1.16	1.22									
Parkersburg, W. Va.	1			1.78														.50			
Pensacola, Fla.	18	1:20 p. m.	5:05 p. m.	1.30	2:17 p. m.	2:43 p. m.	.01	.21	.31	.38	.43	.55	.58								
Peoria, Ill.	17			0.24														.20			
Philadelphia, Pa.	1-2			0.64														*			
Phoenix, Ariz.	14			T.														T.			
Pierre, S. Dak.	2			0.12														.12			
Pittsburgh, Pa.	1			1.50														.38			
Pocatello, Idaho	14			0.04														.03			
Point Reyes Light, Cal.	23			0.07														.03			
Port Huron, Mich.	13			0.34														.12			
Portland, Me.	2			0.55														.15			
Portland, Oreg.	1-2			0.62														.25			
Providence, R. I.	5			0.75														.24			
Pueblo, Colo.	15			0.23														.10			
Raleigh, N. C.	6-7			1.72														.22			
Rapid City, S. Dak.	15-16			1.23														.17			
Reading, Pa.	19-20			1.55														.43			
Red Bluff, Cal.	23			.15														.15			
Reno, Nev.	13			T.														T.			
Richmond, Va.	5-6			0.99														.37			
Rochester, N. Y.	5			0.84														.35			
Roseburg, Oreg.	22-23			0.49														.19			
Roswell, N. Mex.	5			0.09														.08			
Sacramento, Cal.	13, 23			T.														T.			
Saginaw, Mich.	13			0.23														.10			
St. Joseph, Mo.	12			0.26														.09			
St. Louis, Mo.	4			0.19														.16			
St. Paul, Minn.	3			0.66														.26			
Salt Lake City, Utah	3			0.01														.01			
San Antonio, Tex.	18	1:45 a. m.	8:22 a. m.	1.01	1:56 a. m.	2:11 a. m.	.03	.17	.31	.38											
San Diego, Cal.	‡																				
Sand Key, Fla.	25-26	3:54 p. m.	10:56 p. m.	3.30	5:23 p. m.	5:49 p. m.	.20	.13	.37	.49	.59	.70	.75								
					3:19 p. m.	4:03 p. m.	2.27	.05	.12	.25	.32	.36	.46	.67	.74	.82					
	29	9:19 a. m.	12:50 p. m.	1.76	11:19 a. m.	11:58 a. m.	.21	.16	.31	.48	.74	1.11	1.37	1.44	1.49						
Sandusky, Ohio	4			0.27														.25			
San Francisco, Cal.	23			0.01														.01			
San Jose, Cal.	‡																				
San Luis Obispo, Cal.	‡																				
Santa Fe, N. Mex.	14			0.03														.02			
Sault Ste. Marie, Mich.	18-19			0.71														*			
Savannah, Ga.	5	5:46 p. m.	7:30 p. m.	0.80	6:14 p. m.	6:37 p. m.	.01	.11	.22	.50	.68	.74									
Scranton, Pa.	5			0.18														.17			
Seattle, Wash.	18			0.78														.26			
Sheridan, Wyo.	10			0.21														.06			
Shreveport, La.	4	12:30 p. m.	1:00 p. m.	0.66	12:38 p. m.	12:52 p. m.	.01	.29	.59	.64											
Sioux City, Iowa	3	6:05 a. m.	8:10 a. m.	0.71	6:22 a. m.	6:33 a. m.	.02	.20	.34	.37											
Spokane, Wash.	3			0.07														.07			
Springfield, Ill.	13			0.24														.18			
Springfield, Mo.	12			0.73														.52			
Syracuse, N. Y.	1-3			1.71														*			
Tacoma, Wash.	26			0.36														.13			
Tampa, Fla.	8			0.55														.21			
Tatoosh Island, Wash.	24-25			2.50														.40			
Taylor, Tex.	17-18	10:24 p. m.	7:14 a. m.	1.65	2:49 a. m.	3:59 a. m.	.24	.08	.21	.34	.45	.51	.51	.51	.53	.57	.76	.95	1.29		
Terre Haute, Ind.	17	3:00 p. m.	7:30 p. m.	0.44	5:47 p. m.	5:58 p. m.	.07	.18	.32	.36											
Thomasville, Ga.	5	1:05 p. m.	3:15 p. m.	0.85	2:05 p. m.	2:18 p. m.	.17	.22	.57	.66											
	20-21	11:46 a. m.	8:38 a. m.	5.61	11:29 p. m.	1:41 a. m.	2.67	.11	.18	.26	.38	.43	.50	.57	.69	.80	.97				
								1.14	1.29	1.48	1.66	1.78	1.88	1.96	2.03	2.10	2.19				
								2.30	2.40	2.50	2.56	2.61									
Toledo, Ohio	13-14			1.07														.80			

*Self-register not working. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during October, 1915, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Tonopah, Nev.	‡																				
Topeka, Kans.	15			0.31														0.17			
Valentine, Nebr.	15-16			1.28														.23			
Vicksburg, Miss.	4			1.43														.38			
Walla Walla, Wash.	23			0.38														.16			
Washington, D. C.	1			2.27														.60			
Wichita, Kans.	15			1.19														.69			
Williston, N. Dak.	3			0.91														.34			
Wilmington, N. C.	21			0.39														.25			
Wytheville, Va.	1			0.65														.25			
Yankton, S. Dak.	3			0.44														.38			
Yellowstone Park, Wyo.	24			0.15														*			

* Self-register not working. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, October, 1915.*

Stations.	Pressure.			Temperature.						Precipitation.		
	Station reduced to mean of 24 hours.	Sea level reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Inches.	*Inches.*	*Inches.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	29.84	29.98	+0.07	46.0	+0.6	52.1	40.0	70	32	3.75	−1.60	
Sydney, C. B. I.	29.96	30.00	+.04	49.7	+3.2	58.5	41.0	72	30	2.90	−1.79	
Halifax, N. S.	29.93	30.04	+.04	50.0	+2.8	59.0	41.1	73	30	6.75	+1.20	
Yarmouth, N. S.	29.96	30.03	+.01	48.7	+1.1	54.4	43.1	62	33	6.62	+1.92	
Charlottetown, P. E. I.	29.96	30.00	+.04	48.5	+2.0	55.1	41.9	67	31	3.73	−1.17	
Chatham, N. B.	29.98	30.00	+.04	47.5	+4.5	56.5	38.5	72	28	2.73	−1.13	0.1
Father Point, Que.	29.95	29.97	+.02	43.4	+3.6	49.9	36.8	65	26	3.38	+0.48	
Quebec, Que.	29.70	30.02	+.02	46.4	+2.0	53.2	39.5	66	28	2.99	−0.16	
Montreal, Que.	29.82	30.03	+.02	49.7	+4.9	56.2	43.1	70	31	1.75	−1.38	T.
Stonecliffe, Ont.	29.44	30.05	+.04	47.3	+4.5	56.4	38.2	73	23	1.40	−1.03	
Ottawa, Ont.	29.77	30.09	+.08	49.2	+5.4	57.7	40.8	72	26	1.33	−1.22	T.
Kingston, Ont.	29.75	30.06	+.03	51.8	+4.8	58.8	44.8	68	28	1.70	−1.03	
Toronto, Ont.	29.65	30.03	−.01	51.9	+5.3	60.0	43.8	74	30	2.18	−0.18	
White River, Ont.	28.61	29.94	+.04	39.9	+2.8	48.8	31.0	66	12	3.54	+1.19	2.6
Port Stanley, Ont.	29.40	30.04	−.01	50.6	+2.8	58.6	42.5	69	26	1.79	−1.19	
Southampton, Ont.	29.33			50.4	+4.3	58.0	42.9	77	28	1.82	−1.35	
Parry Sound, Ont.	29.33	30.03	+.02	48.2	+4.3	56.3	40.1	73	25	3.40	−0.52	
Port Arthur, Ont.	29.24	29.95	−.03	43.0	+3.1	50.0	36.0	62	28	2.50	−0.06	
Winnipeg, Man.	29.08	29.92	−.06	44.8	+5.7	55.6	34.1	71	24	1.03	−0.67	0.2
Minnedosa, Man.	28.10	29.94	−.03	41.8	+4.0	53.6	30.0	68	17	0.35	−0.85	1.2
Qu'Appelle, Sask.	27.62	29.87	−.10	43.8	+4.4	56.5	31.0	70	20	0.36	−0.74	0.2
Medicine Hat, Alberta.	27.61	29.89	−.08	50.4	+5.6	62.7	38.0	78	29	1.01	+0.43	
Swift Current, Sask.	27.29	29.86	−.11	46.3	+4.2	59.4	33.1	78	22	0.71	−0.17	1.4
Calgary, Alberta.	26.26	29.77	−.18	45.0	+4.9	58.7	31.2	76	26	2.17	+1.69	
Banff, Alberta.	25.32	29.92	−.03	41.2	+1.9	48.9	33.5	59	21	1.73	+0.71	4.0
Edmonton, Alberta.	27.54	29.84	−.09	42.4	+1.3	53.6	31.2	72	16	0.21	−0.49	T.
Prince Albert, Sask.	28.27	29.84	−.13	38.5	+1.4	46.6	30.5	62	21	0.37	−0.46	T.
Battleford, Sask.	28.13	29.87	−.10	43.4	+3.8	57.1	29.7	72	21	0.32	−0.13	
Kamloops, B. C.	28.73	30.00	+.04	50.3	+3.3	58.8	41.8	70	30	0.80	+0.19	
Victoria, B. C.	29.79	30.05	+.04	51.1	+1.9	55.5	46.7	63	43	4.20	+1.83	
Barkerville, B. C.	25.50	29.80	−.14	36.7	−3.0	43.0	30.4	55	20	5.20	+2.50	22.7
Hamilton, Bermuda.	29.92	30.08	+.06	72.4	−0.6	78.0	66.8	81	62	1.34	−5.37	

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Chart I. Hydrographs of Several Principal Rivers, October, 1915.

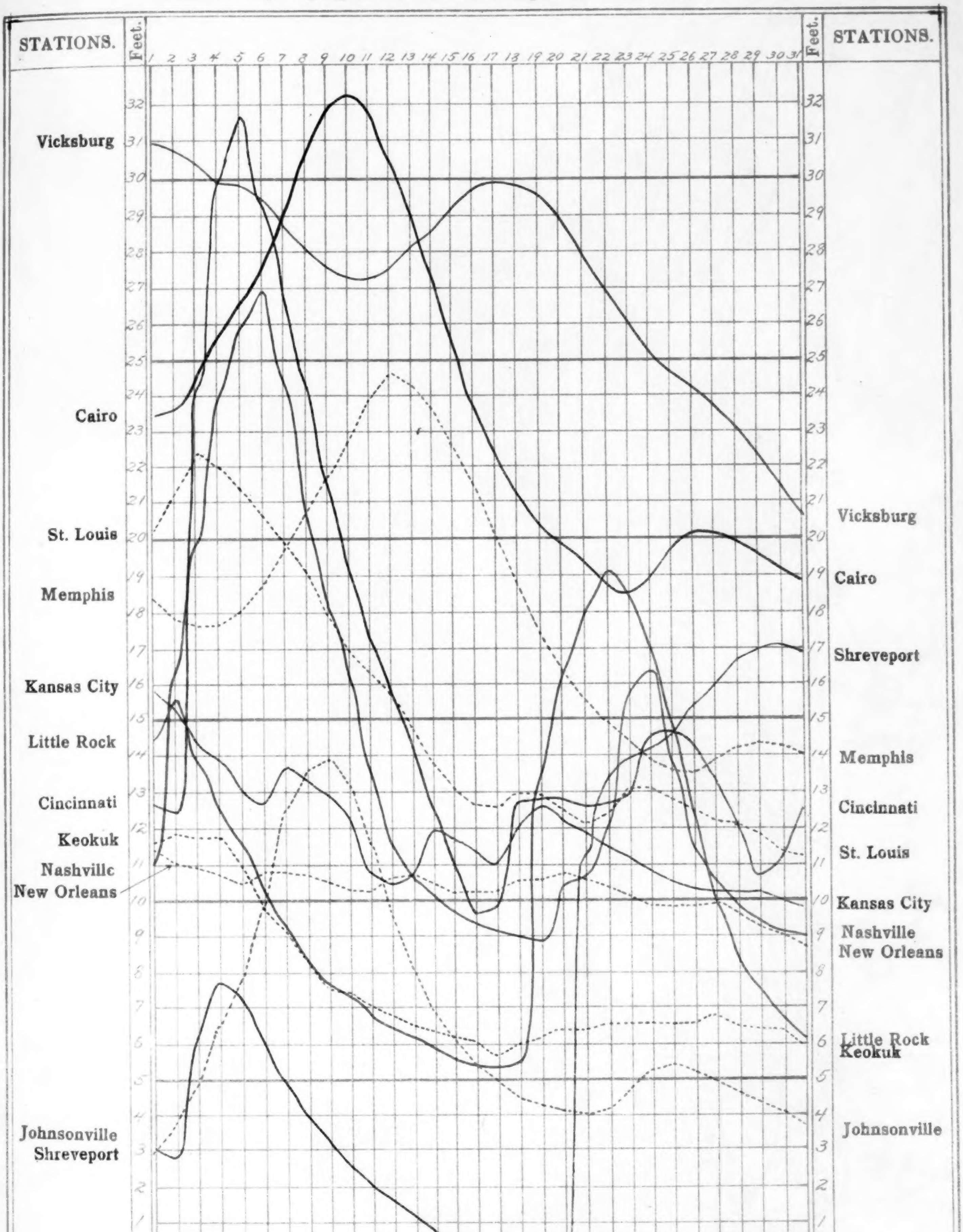

Chart II. Tracks of Centers of High Areas, October, 1915.

(Plotted by R. H. Weightman.)

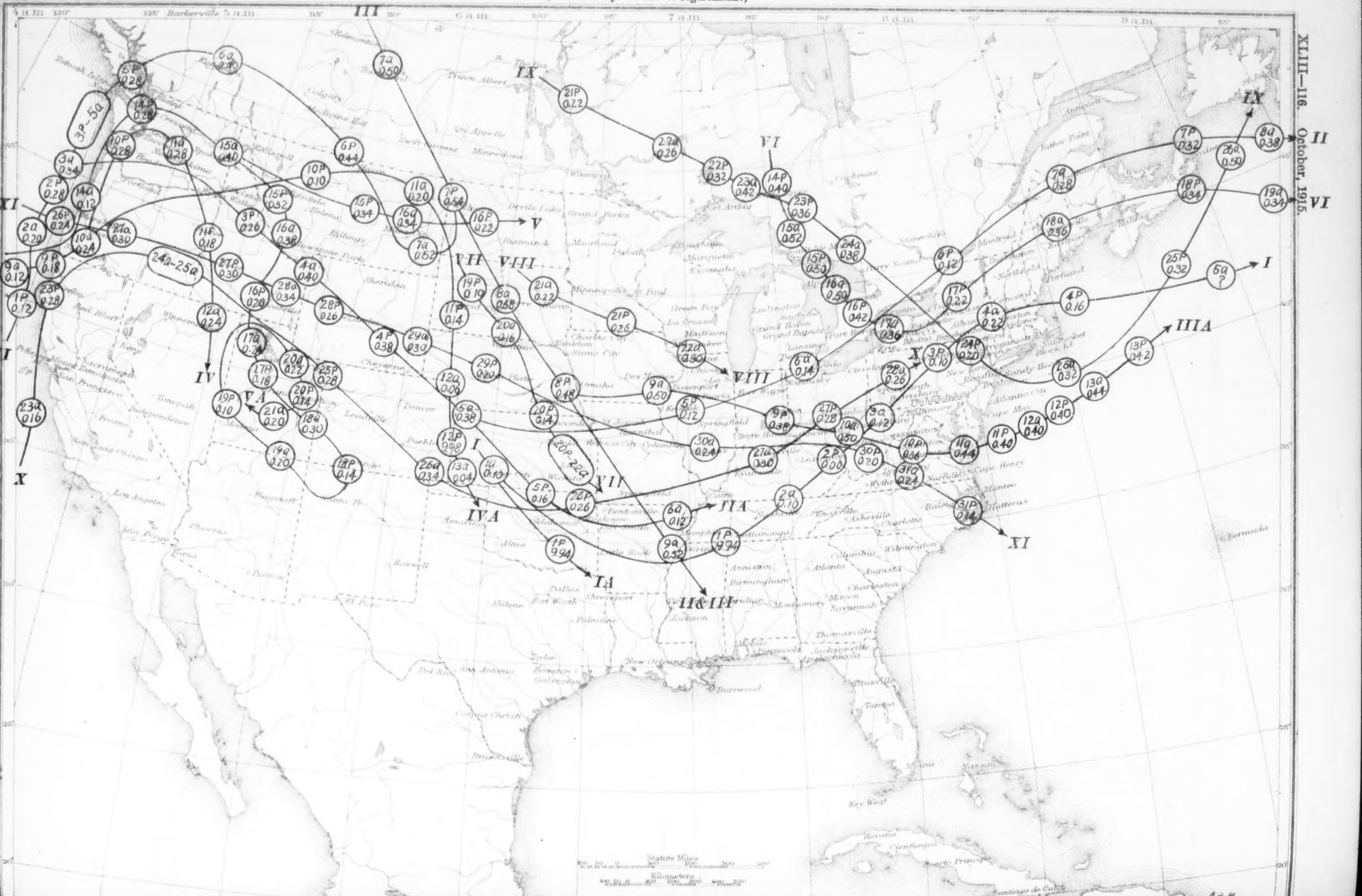

Chart III. Tracks of Centers of Low Areas, October, 1915.
(Plotted by R. H. Weightman.)

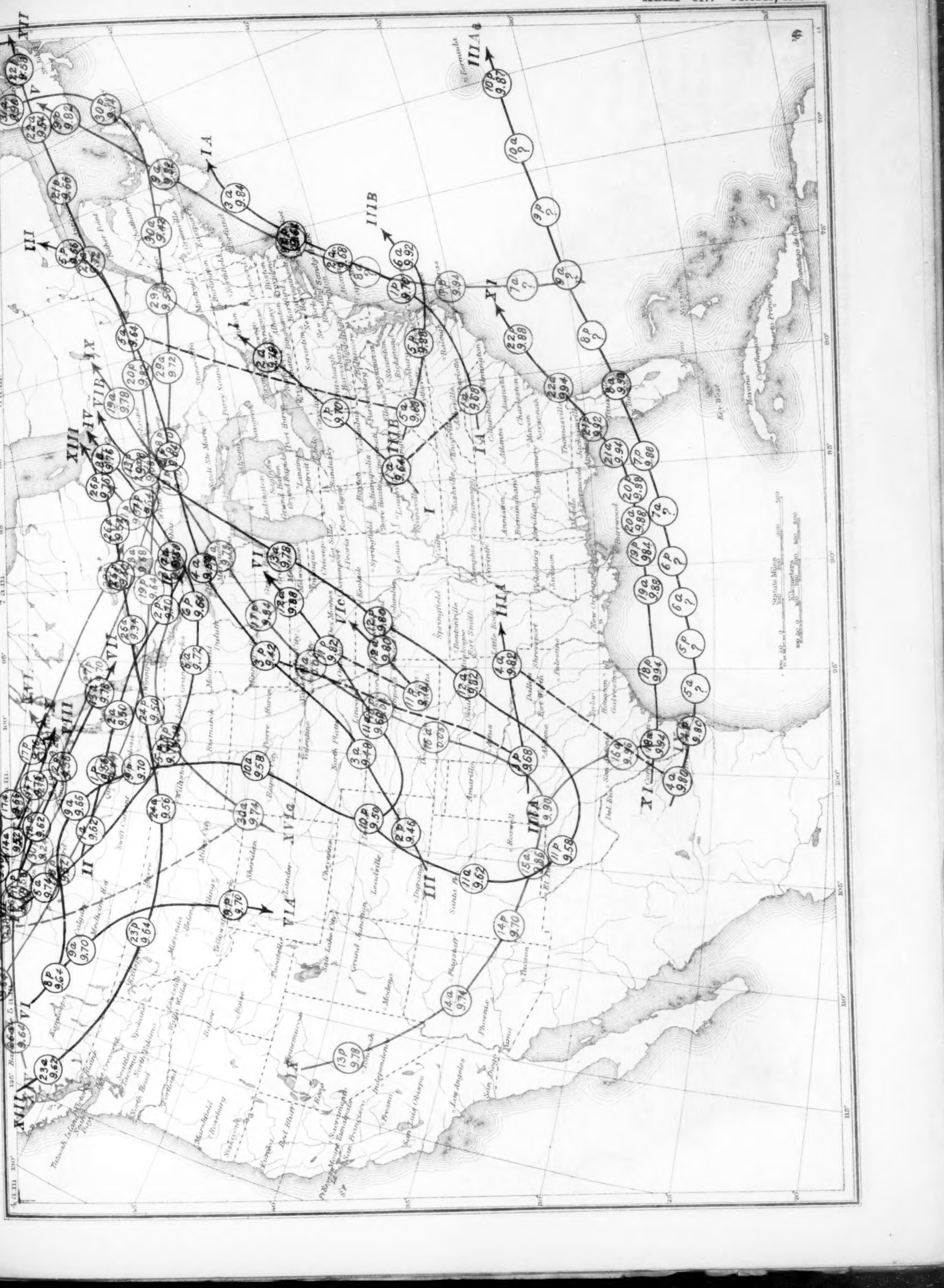

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, October, 1915.

Shaded portions show excess (+).
Unshaded portions show deficiency (−).
Lines show amount of excess or deficiency.

Chart V. Total Precipitation, Inches, October, 1915.

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, October, 1915.

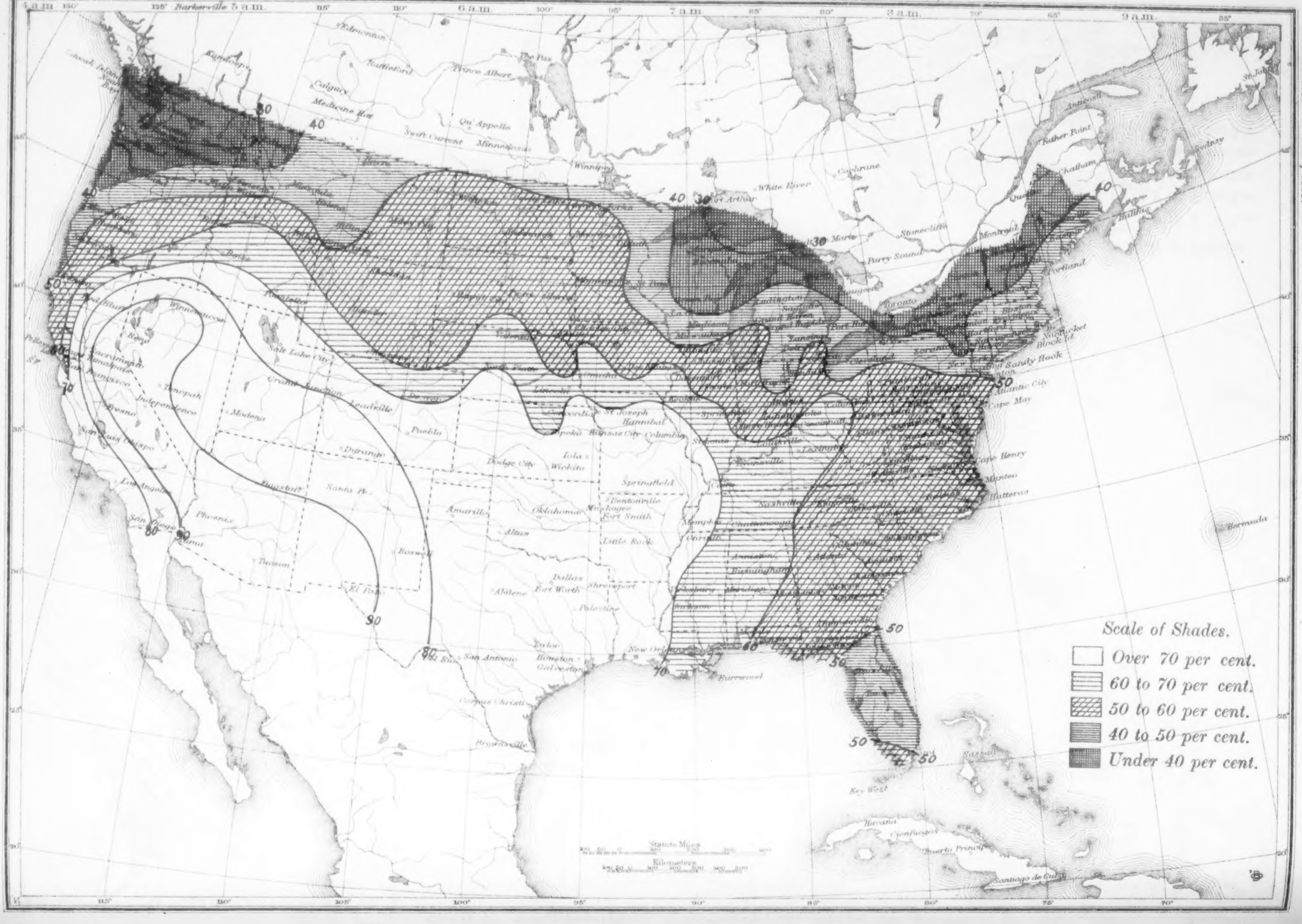

Chart VII. Isobars and Isotherms at Sea Level; Prevailing Winds, October, 1915.

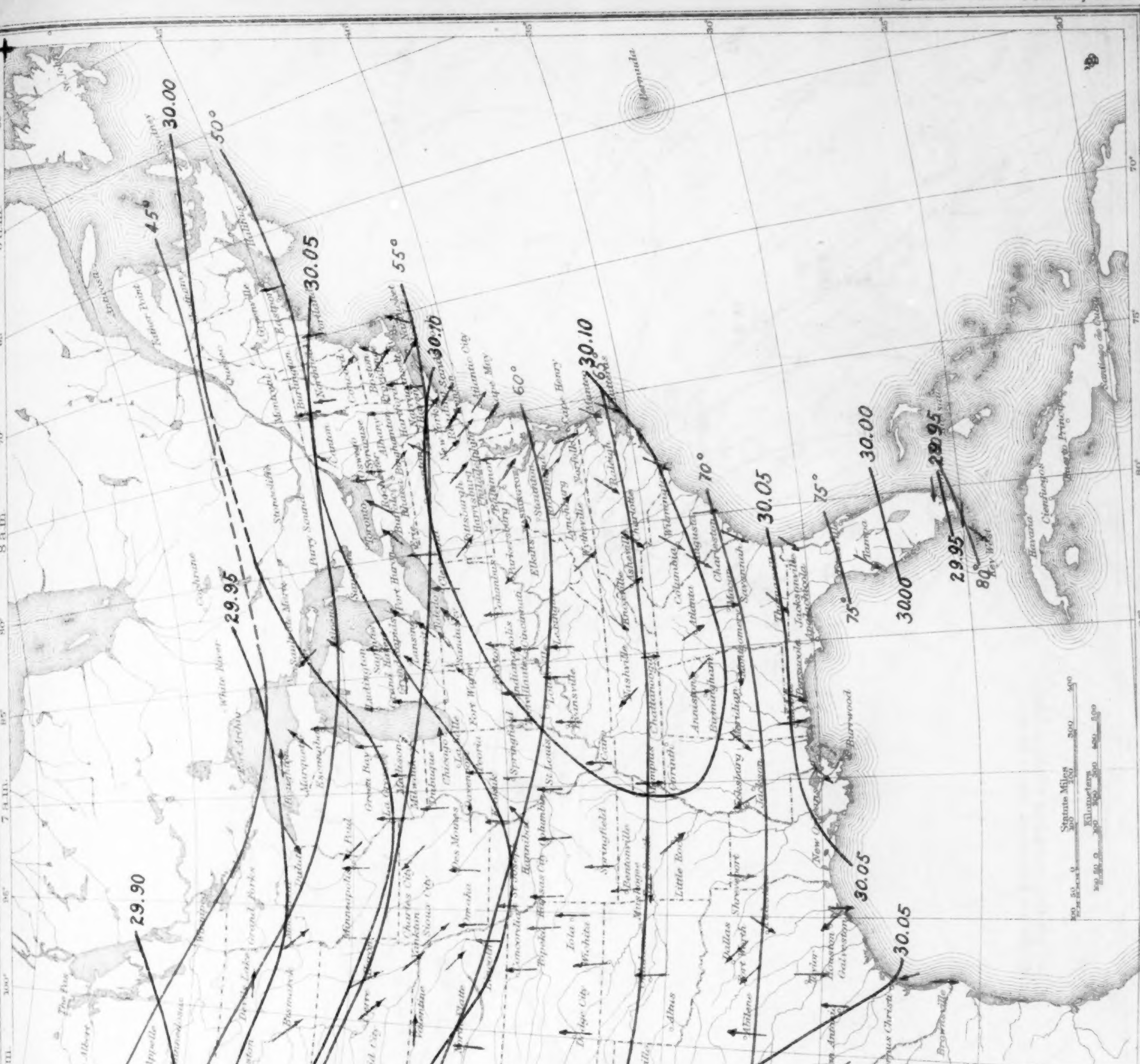

Chart IX. Means of Meteorological Data for North Atlantic Ocean, October, 1914.